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NOTICE OF ALLOWANCE AND FEE(S) DUE

25944 7590 06/23/2004

OLIFF & BERRIDGE, PLC
P.O. BOX 19928
ALEXANDRIA, VA 22320

EXAMINER	
TRIEU, THAI BA	
ART UNIT	PAPER NUMBER
3748	

DATE MAILED: 06/23/2004

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/695,873	10/30/2003	Akio Matsunaga	117463	6679

TITLE OF INVENTION: EGR-GAS TEMPERATURE ESTIMATION APPARATUS FOR INTERNAL COMBUSTION ENGINE

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1330	$300	$1630	09/23/2004

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE REFLECTS A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE APPLIED IN THIS APPLICATION. THE PTOL-85B (OR AN EQUIVALENT) MUST BE RETURNED WITHIN THIS PERIOD EVEN IF NO FEE IS DUE OR THE APPLICATION WILL BE REGARDED AS ABANDONED.

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:
A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status is changed, pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above and notify the United States Patent and Trademark Office of the change in status, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check the box below and enclose the PUBLICATION FEE and 1/2 the ISSUE FEE shown above.

☐ Applicant claims SMALL ENTITY status. See 37 CFR 1.27.

II. PART B - FEE(S) TRANSMITTAL should be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). Even if the fee(s) have already been paid, Part B - Fee(s) Transmittal should be completed and returned. If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PTOL-85 (Rev. 11/03) Approved for use through 04/30/2004.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
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or Fax **(703) 746-4000**

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 4 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Legibly mark-up with any corrections or use Block 1)

25944 7590 06/23/2004

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Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/695,873	10/30/2003	Akio Matsunaga	117463	6679

TITLE OF INVENTION: EGR-GAS TEMPERATURE ESTIMATION APPARATUS FOR INTERNAL COMBUSTION ENGINE

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1330	$300	$1630	09/23/2004

EXAMINER	ART UNIT	CLASS-SUBCLASS
TRIEU, THAI BA	3748	060-605200

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list (1) the names of up to 3 registered patent attorneys or agents OR, alternatively, (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____

2 _____

3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. Inclusion of assignee data is only appropriate when an assignment has been previously submitted to the USPTO or is being submitted under separate cover. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent); ❑ individual ❑ corporation or other private group entity ❑ government

4a. The following fee(s) are enclosed:

❑ Issue Fee

❑ Publication Fee

❑ Advance Order - # of Copies _____

4b. Payment of Fee(s):

❑ A check in the amount of the fee(s) is enclosed.

❑ Payment by credit card. Form PTO-2038 is attached.

❑ The Director is hereby authorized by charge the required fee(s), or credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

Director for Patents is requested to apply the Issue Fee and Publication Fee (if any) or to re-apply any previously paid issue fee to the application identified above.

(Authorized Signature) (Date)

NOTE; The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

TRANSMIT THIS FORM WITH FEE(S)

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/695,873	10/30/2003	Akio Matsunaga	117463	6679

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EXAMINER	
TRIEU, THAI BA	
ART UNIT	**PAPER NUMBER**
3748	

DATE MAILED: 06/23/2004

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 0 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 0 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) system (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (703) 305-1383. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at (703) 305-8283.

PTOL-85 (Rev. 11/03) Approved for use through 04/30/2004.

Notice of Allowability	Application No.	Applicant(s)	
	10/695,873	MATSUNAGA ET AL.	
	Examiner	Art Unit	
	Thai-Ba Trieu	3748	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☐ This communication is responsive to _____.

2. ☒ The allowed claim(s) is/are *1-12*.

3. ☐ The drawings filed on _____ are accepted by the Examiner.

4. ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☒ All b) ☐ Some* c) ☐ None of the:
      1. ☒ Certified copies of the priority documents have been received.
      2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
      3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

6. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
      1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

7. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☒ Information Disclosure Statements (PTO-1449 or PTO/SB/08), Paper No./Mail Date 10/30/2003
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application (PTO-152)
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
7. ☒ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

DETAILED ACTION

Priority

Receipt is acknowledged of papers submitted under 35 U.S.C. 119(a)-(d), which papers have been placed of record in the file.

EXAMINER'S AMENDMENT

The application has been amended as follows:

- On Page 13, line 22, ***"a throttle vale 33"*** has been replaced by – **a throttle valve 33** --, (for correcting typo error).

- On Page 14, line 26, ***"rear earth"*** has been replaced by –**rare earth**--, (for correcting typo error).

Allowable Subject Matter

Claims 1-10 are allowed.

The following is an examiner's statement of reasons for allowance: The Prior Art fails to disclose or render obvious the claimed combination of an EGR-gas temperature estimation apparatus for an internal combustion engine including:

" **Regarding claims 1 and 7:**

outlet EGR-gas temperature estimating means for estimating a temperature of the EGR gas on an outlet side of the EGR-gas cooling apparatus, on the basis of the EGR-gas temperature on the inlet side of the EGR-gas cooling apparatus and the obtained cooling efficiency."

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

The IDS (PTO-1449) filed on October 30, 2003 has been considered. An initialized copy is attached hereto.

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

- Hernandez et al. (Pub. Number US 2003/0226398 A1) disclose methods and apparatus for estimating the temperature of an exhaust gas recirculation valve coil.

- Brunemann et al. (Pub. Number 2003/0192516 A1) disclose a condensation protection AECD for an internal combustion engine employing cooled EGR.

- Hernandez (US Patent Number 6,622,548 B1) discloses methods and apparatus for estimating gas temperatures within a vehicle engine.

- Zagone (US Patent Number 6,434,476 B1) discloses high-voltage fault discrimination for EGR temperature sensor.

- Kreso (US Patent Number 6,347,519 B1) discloses a system and a method for measuring recirculation exhaust gas flow in a compression-ignition engine.

- Akao et al. (US Patent Number 6,708,676 B2) discloses an EGR control unit and EGR control method.

- Cullen et al. (US Patent Number 6,116,083) discloses an exhaust gas temperature estimation.

- Wang et al. (US Patent Number 6,085,732) disclose an EGR fault diagnostic system.

- Fukuma (Patent Number 6,000,385) discloses a combustion engine with EGR apparatus.

- Shibata et al. (Patent Number JP 2002129996 A) disclose exhaust emission control device for an internal combustion engine.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thai-Ba Trieu whose telephone number is (703) 308-6450. The examiner can normally be reached on Monday - Thursday (6:30-5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Thomas E. Denion can be reached on (703) 308-2623. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should

you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

TTB
June 20, 2004

Thai-Ba Trieu
Patent Examiner
Art Unit 3748

Sheet 1 of 1

Form PTO-1449 (REV. 8-83)	US Dept. of Commerce PATENT & TRADEMARK OFFICE	ATTY DOCKET NO. 117463	APPLICATION NO. New U.S. Patent Application 10/695,873
INFORMATION DISCLOSURE STATEMENT (Use several sheets if necessary)		APPLICANTS Akio MATSUNAGA et al.	
		FILING DATE October 30, 2003	AU 3748

U.S. PATENT DOCUMENTS

EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUB CLASS

FOREIGN PATENT DOCUMENTS

		DOCUMENT NUMBER	DATE	COUNTRY	CLASS	SUB CLASS
TTB	1	JP A 11-166452 w/abstr. + trans.	06/22/1999	Japan	F02M	25/07

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, etc.)

EXAMINER	DATE CONSIDERED
	04/09/04

Examiner: Initial if citation considered, whether or not citation is in conformance with M.P.E.P. 609; draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Date: October 30, 2003

Notice of References Cited	Application/Control No. 10/695,873	Applicant(s)/Patent Under Reexamination MATSUNAGA ET AL.	
	Examiner Thai-Ba Trieu	Art Unit 3748	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2003/0226398 A1	12-2003	Hernandez et al.	73/118.1
*	B	US-2003/0192516 A1	10-2003	Brunemann et al.	60/605.2
*	C	US-6,622,548 B1	09-2003	Hernandez, Claudio A.	73/118.1
*	D	US-6,434,476 B1	08-2002	Zagone, Peter	123/568.16
*	E	US-6,347,519 B1	02-2002	Kreso, Admir M.	60/605.2
*	F	US-6,708,676 B2	03-2004	Akao et al.	123/568.16
*	G	US-6,116,083	09-2000	Cullen et al.	73/118.1
*	H	US-6,085,732	07-2000	Wang et al.	123/568.16
*	I	US-6,000,385	12-1999	Fukuma, Takao	123/568.16
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N	JP 2002129996 A	05-2002	Japan	SHIBATA et al.	F02M 25/07
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

USPTO TO PROVIDE ELECTRONIC ACCESS TO CITED U.S. PATENT REFERENCES WITH OFFICE ACTIONS AND CEASE SUPPLYING PAPER COPIES

In support of its 21st Century Strategic Plan goal of increased patent e-Government, beginning in June 2004, the United States Patent and Trademark Office (Office or USPTO) will begin the phase-in of its E-Patent Reference program and hence will: (1) **provide downloading capability of the U.S. patents and U.S. patent application publications cited in Office actions** via the E-Patent Reference feature of the Office's Patent Application Information Retrieval (PAIR) system; and (2) **cease mailing paper copies of U.S. patents and U.S. patent application publications with Office actions** (in applications and during reexamination proceedings) except for citations made during the international stage of an international application under the Patent Cooperation Treaty (PCT). In order to use the new E-Patent Reference feature applicants must: (1) obtain a digital certificate and software from the Office; (2) obtain a customer number from the Office; and (3) properly associate patent applications with the customer number. Alternatively, copies of all U.S. patents and patent application publications can be accessed without a digital certificate from the USPTO web site, from the USPTO Office of Public Records, and from commercial sources. The Office will continue the practice of supplying paper copies of foreign patent documents and non-patent literature with Office actions. Paper copies of cited references will continue to be provided by the USPTO for international applications during the international stage.

Schedule

June 2004	TCs 1600, 1700, 2800 and 2900
July 2004	TCs 3600 and 3700
August 2004	TCs 2100 and 2600

All U.S. patents and U.S. patent application publications are available on the USPTO web site. However, a simple system for downloading the cited U.S. patents and patent application publications has been established for applicants, called the E-Patent Reference system. As E-Patent Reference and Private PAIR require participating applicants to have a customer number, retrieval software and a digital certificate, all applicants are strongly encouraged to contact the Patent Electronic Business Center to acquire these items. To be ready to use this system by June 1, 2004, contact the Patent EBC as soon as possible by phone at 866-217-9197 (toll-free), 703-305-3028 or 703-308-6845 or electronically via the Internet at ebc@uspto.gov.

Other Options

The E-Patent Reference function requires the applicant to use the secure Private PAIR system, which establishes confidential communications with the applicant. Applicants using this facility must receive a digital certificate, as described above. Other options for obtaining patents which do not require the digital certificate include the USPTO's free Patents on the Web program (http://www.uspto.gov/patft/index.html). The USPTO's Office of Public Records also supplies copies of patents for a fee (http://ebiz1.uspto.gov/oems25p/index.html). Commercial sources also provide U.S. patents and patent application publications.

For complete instructions see the Official Gazette Notice, USPTO TO PROVIDE ELECTRONIC ACCESS TO CITED U.S. PATENT REFERENCES WITH OFFICE ACTIONS AND CEASE SUPPLYING PAPER COPIES, on the USPTO web site.

NOTICE OF OFFICE PLAN TO CEASE SUPPLYING COPIES OF CITED U.S. PATENT REFERENCES WITH OFFICE ACTIONS, AND PILOT TO EVALUATE THE ALTERNATIVE OF PROVIDING ELECTRONIC ACCESS TO SUCH U.S. PATENT REFERENCES

Summary

The United States Patent and Trademark Office (Office or USPTO) plans in the near future to: (1) cease mailing copies of U.S. patents and U.S. patent application publications (US patent references) with Office actions except for citations made during the international stage of an international application under the Patent Cooperation Treaty and those made during reexamination proceedings; and (2) provide electronic access to, with convenient downloading capability of, the US patent references cited in an Office action via the Office's private Patent Application Information Retrieval (PAIR) system which has a new feature called "E-Patent Reference." Before ceasing to provide copies of U.S. patent references with Office actions, the Office shall test the feasibility of the E-Patent Reference feature by conducting a two-month pilot project starting with Office actions mailed after December 1, 2003. The Office shall evaluate the pilot project and publish the results in a notice which will be posted on the Office's web site (www.USPTO.gov) and in the Patent Official Gazette (O.G.). In order to use the new E-Patent Reference feature during the pilot period, or when the Office ceases to send copies of U.S. patent references with Office actions, the applicant must: (1) obtain a digital certificate from the Office; (2) obtain a customer number from the Office, and (3) properly associate applications with the customer number. The pilot project does not involve or affect the current Office practice of supplying paper copies of foreign patent documents and non-patent literature with Office actions. Paper copies of references will continue to be provided by the USPTO for searches and written opinions prepared by the USPTO for international applications during the international stage and for reexamination proceedings.

Description of Pilot Project to Provide Electronic Access to Cited U.S. Patent References

On December 1, 2003, the Office will make available a new feature, E-Patent Reference, in the Office's private PAIR system, to allow more convenient downloading of U.S. patents and U.S. patent application publications. The new feature will allow an authorized user of private PAIR to download some or all of the U.S. patents and U.S. patent application publications cited by an examiner on form PTO-892 in Office actions, as well as U.S. patents and U.S. patent application publications submitted by applicants on form PTO/SB08 (1449) as part of an IDS. The retrieval of some or all of the documents may be performed in one downloading step with the documents encoded as Adobe Portable Document format (.pdf) files, which is an improvement over the current page-by-page retrieval capability from other USPTO systems.

Steps to Use the New E-Patent Reference Feature During the Pilot Project and Thereafter

Access to private PAIR is required to utilize E-Patent Reference. If you don't already have access to private PAIR, the Office urges practitioners, and applicants not represented by a practitioner, to take advantage of the transition period to obtain a no-cost USPTO Public Key Infrastructure (PKI) digital certificate, obtain a USPTO customer number, associate all of their pending and new application filings with their customer number, install no-cost software (supplied by the Office) required to access private PAIR and E-Patent Reference feature, and make appropriate arrangements for Internet access. The full instructions for obtaining a PKI digital certificate are available at the Office's Electronic Business Center (EBC) web page at: <http://www.uspto.gov/ebc/downloads.html>. Note that a notarized signature will be required to obtain a digital certificate.

To get a Customer Number, download and complete the Customer Number Request form, PTO-SB125, at: http://www.uspto.gov/web/forms/sb0125.pdf. The completed form can then be transmitted by facsimile to the Electronic Business Center at (703) 308-2840, or mailed to the address on the form. If you are a registered attorney or patent agent, then your registration number must be associated with your customer number. This is accomplished by adding your registration number to the Customer Number Request form. A description of associating a customer number with an application is described at the EBC web page at: http://www.uspto.gov/ebc/registration_pair.html.

The E-Patent Reference feature will be accessed using a new button on the private PAIR screen. Ordinarily all of the cited U.S. patent and U.S. patent application publication references will be available over the Internet using the Office's new E-Patent Reference feature. The size of the references to be downloaded will be displayed by E-Patent Reference so the download time can be estimated. Applicants and registered practitioners can select to download all of the references or any combination of cited references. Selected references will be downloaded as complete documents as Adobe Portable Document Format (.pdf) files. For a limited period of time, the USPTO will include a copy of this notice with Office actions to encourage applicants to use this new feature and, if needed, to take the steps outlined above in order to be able to utilize this new feature during the pilot and thereafter.

During the two-month pilot, the Office will evaluate the stability and capacity of the E-Patent Reference feature to reliably provide electronic access to cited U.S. patent and U.S. patent application publication references. While copies of U.S. patent and U.S. patent application publication references cited by examiners will continue to be mailed with Office actions during the pilot project, applicants are encouraged to use the private PAIR and the E-Patent Reference feature to electronically access and download cited U.S. patent and U.S. patent application publication references so the Office will be able to objectively evaluate its performance. The public is encouraged to submit comments to the Office on the usability and performance of the E-Patent Reference feature during the pilot. Further, during the pilot period registered practitioners, and applicants not represented by a practitioner, are encouraged to experiment with the feature, develop a proficiency in using the feature, and establish new internal processes for using the new access to the cited U.S. patents and U.S. patent application publications to prepare for the anticipated cessation of the current Office practice of supplying copies of such cited

references. The Office plans to continue to provide access to the E-Patent Reference feature during its evaluation of the pilot.

Comments

Comments concerning the E-Patent Reference feature should be in writing and directed to the Electronic Business Center (EBC) at the USPTO by electronic mail at eReference@uspto.gov or by facsimile to (703) 308-2840. Comments will be posted and made available for public inspection. To ensure that comments are considered in the evaluation of the pilot project, comments should be submitted in writing by January 15, 2004.

Comments with respect to specific applications should be sent to the Technology Centers' customer service centers. Comments concerning digital certificates, customer numbers, and associating customer numbers with applications should be sent to the Electronic Business Center (EBC) at the USPTO by facsimile at (703) 308-2840 or by e-mail at EBC@uspto.gov.

Implementation after Pilot

After the pilot, its evaluation, and publication of a subsequent notice as indicated above, the Office expects to implement its plan to cease mailing paper copies of U.S. patent references cited during examination of non provisional applications on or after February 2, 2004; although copies of cited foreign patent documents, as well as non-patent literature, will still be mailed to the applicant until such time as substantially all applications have been scanned into IFW.

For Further Information Contact

Technical information on the operation of the IFW system can be found on the USPTO website at http://www.uspto.gov/web/patents/ifw/index.html. Comments concerning the E-Patent Reference feature and questions concerning the operation of the PAIR system should be directed to the EBC at the USPTO at (866) 217-9197. The EBC may also be contacted by facsimile at (703) 308-2840 or by e-mail at EBC@uspto.gov.

Date. 12/1/03

Nicholas P. Godici
Commissioner for Patents

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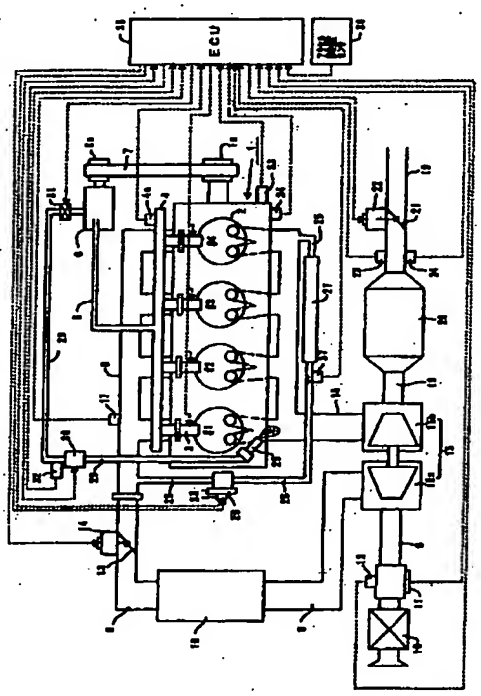
(54)【発明の名称】　内燃機関の排気浄化装置

(57)【要約】
【課題】内燃機関の排気エミッションの悪化防止に寄与する。
【解決手段】　内燃機関１の運転状態を検出する運転状態検出手段３６と、ＥＧＲガスの温度を計測するＥＧＲガス温度計測手段３７と、運転状態及びＥＧＲガス温度に基づいてＥＧＲクーラ２７の冷却効率を推定するＥＧＲクーラ冷却効率推定手段３５と、内燃機関１に吸入される空気の量及びＥＧＲガスの量をパラメータに含み内燃機関１に供給する燃料の量を決定する燃料主噴射量決定手段３５と、内燃機関１の吸入新気量をＥＧＲクーラ冷却効率に基づいて補正する吸入新気量補正手段１４と、内燃機関１のＥＧＲガス量をＥＧＲクーラ冷却効率に基づいて補正するＥＧＲガス量補正手段２６と、を具備した。



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【特許請求の範囲】
【請求項1】　内燃機関の吸気系に排気の一部を再循環させるEGR装置と、
前記EGR装置を再循環するEGRガスを冷却させるEGRクーラと、
を具備する内燃機関の排気浄化装置において、
前記内燃機関の運転状態を検出する運転状態検出手段と、
前記EGR装置を再循環するEGRガスの温度を計測するEGRガス温度計測手段と、
前記運転状態検出手段により検出された運転状態及び前記EGRガス温度計測手段により計測されたEGRガスの温度に基づいて前記EGRクーラの冷却効率を推定するEGRクーラ冷却効率推定手段と、
前記内燃機関に吸入される空気の量及びEGRガスの量をパラメータに含み内燃機関に供給する燃料の量を決定する燃料主噴射量決定手段と、
前記EGRクーラ冷却効率と共に変化する内燃機関に吸入される新気の量を前記EGRクーラ冷却効率推定手段により推定されたEGRクーラ冷却効率に基づいて補正する吸入新気量補正手段と、
前記EGRクーラ冷却効率と共に変化する内燃機関に吸入されるEGRガスの量を前記EGRクーラ冷却効率推定手段により推定されたEGRクーラ冷却効率に基づいて補正するEGRガス量補正手段と、
を具備することを特徴とする内燃機関の排気浄化装置。
【請求項2】　前記EGRクーラ冷却効率推定手段は、予め求められたEGRクーラの冷却効率とEGRクーラを通過した後のEGRガス温度との相関関係に基づいてEGR冷却効率を算出することを特徴とする請求項1に記載の内燃機関の排気浄化装置。
【発明の詳細な説明】
【0001】
【発明の属する技術分野】本発明は、内燃機関の排気を浄化する排気浄化装置、特に排気ガス再循環装置に関する。
【0002】
【従来の技術】近年、自動車等に搭載される内燃機関、特に酸素過剰状態の混合気（所謂、リーン空燃比の混合気）を燃焼可能とするディーゼル機関やリーンバーン・ガソリン機関では、該内燃機関の排気中に含まれる窒素酸化物（NOx）を浄化する技術が望まれている。
【0003】このような要求に対し、内燃機関の排気系にリーンNOx触媒を配置する技術が提案されている。リーンNOx触媒の一つとして、流入する排気の酸素濃度が高いときは排気中の窒素酸化物（NOx）を吸収し、流入する排気の酸素濃度が低下し且つ還元剤が存在するときは吸収していた窒素酸化物（NOx）を放出しつつ窒素（N_2）に還元する吸蔵還元型NOx触媒が知られている。

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【0004】吸蔵還元型NOx触媒が内燃機関の排気系に配置されると、内燃機関が希薄燃焼運転されて排気の空燃比が高くなるときは排気中の窒素酸化物（NOx）が吸蔵還元型NOx触媒に吸収され、吸蔵還元型NOx触媒に流入する排気の空燃比が低くなったときは吸蔵還元型NOx触媒に吸収されていた窒素酸化物（NOx）が放出されつつ窒素（N_2）に還元される。
【0005】ところで、吸蔵還元型NOx触媒のNOx吸収能力には限りがあるため、内燃機関が長期にわたって希薄燃焼運転されると、吸蔵還元型NOx触媒のNOx吸収能力が飽和し、排気中の窒素酸化物（NOx）が吸蔵還元型NOx触媒によって除去されることなく大気中に放出されることになる。
【0006】従って、吸蔵還元型NOx触媒を希薄燃焼式内燃機関に適用する場合は、吸蔵還元型NOx触媒のNOx吸収能力が飽和する前に該吸蔵還元型NOx触媒に流入する排気の空燃比を低下させる、所謂リッチスパイク制御を実行することにより、吸蔵還元型NOx触媒に吸収されている窒素酸化物（NOx）を放出及び還元させる必要がある。
【0007】リッチスパイク制御の具体的な方法としては、吸蔵還元型NOx触媒より上流を流れる排気中に還元剤たる燃料を添加する方法を例示することができる。
【0008】尚、吸蔵還元型NOx触媒より上流の排気中に還元剤を添加する場合は、吸蔵還元型NOx触媒に吸収されている窒素酸化物（NOx）に応じて還元剤の添加量を正確に制御することも重要である。
【0009】これは、吸蔵還元型NOx触媒に吸収されている窒素酸化物（NOx）に対して還元剤の添加量が過剰に多くされると余剰の還元剤が大気中に放出されることになり、吸蔵還元型NOx触媒に吸収されている窒素酸化物（NOx）に対して還元剤の添加量が不足すると吸蔵還元型NOx触媒のNOx吸収能力が飽和し、排気中の窒素酸化物（NOx）が浄化されずに大気中に放出されることになるからである。
【0010】このような問題に対し、従来では、特許第2845056号公報に記載されたような内燃機関の排気浄化装置が提案されている。この公報に記載された内燃機関の排気浄化装置は、吸蔵還元型NOx触媒において排気中の酸素と反応して消費される還元剤の量と吸蔵還元型NOx触媒に吸収されている窒素酸化物（NOx）を還元するために必要となる還元剤の量とを考慮して、還元剤の添加量を決定することにより、還元剤の過剰供給や供給不足を防止、以て還元剤や窒素酸化物（NOx）の大気中への放出による排気エミッションの悪化を抑制しようとするものである。
【0011】また、内燃機関から排出される窒素酸化物（NOx）の量を低減する方法としては、内燃機関の排気通路を流れる排気の一部を該内燃機関の吸気通路へ再循環させる排気再循環（EGR：Exhaust Gas Recircul

ation）装置を利用する方法が提案されている。

【００１２】ＥＧＲ装置は、排気中に含まれる水蒸気（H_2O）、一酸化炭素（ＣＯ）、二酸化炭素（CO_2）等の不活性ガス成分が持つ不燃性及び吸熱性を利用して、内燃機関の燃焼室における混合気の燃焼速度及び燃焼温度を低下させ、以て燃焼時に発生する窒素酸化物（ＮＯｘ）の量を低減させるものである。

【００１３】尚、上記したようなＥＧＲ装置としては、内燃機関の排気通路と吸気通路とを連通するＥＧＲ通路と、ＥＧＲ通路内を流れる排気（ＥＧＲガス）の流量を調整するＥＧＲ弁とから構成される装置や、ＥＧＲ通路及びＥＧＲ弁に加えてＥＧＲガスを冷却するためのＥＧＲクーラをＥＧＲ通路の途中に設けて構成される装置等、種々の構成の装置が提案されている。

【００１４】

【発明が解決しようとする課題】ところで、前述した公報に記載されたようなリッチスパイク制御を行うディーゼルエンジンのＥＧＲ装置では、ＮＯｘ還元触媒が未活性状態にある場合は、ＥＧＲガス中に含まれる煤や未燃炭化水素（ＨＣ）などのＳＯＦ（Solible Organic Fraction）成分がＮＯｘ還元触媒で消費されずにＥＧＲクーラへ流入することになる。このような事象が繰り返されると、ＥＧＲクーラにＳＯＦ成分が堆積してＥＧＲクーラの目詰まりが発生する虞がある。

【００１５】更に、前記したディーゼルエンジンのＥＧＲ装置では、ＥＧＲクーラやＥＧＲ通路の目詰まりを検出する手段を備えていないため、実際にＥＧＲクーラやＥＧＲ通路の目詰まりが発生した場合には所望量のＥＧＲガスを吸気通路へ再循環させることが困難となり、その結果、内燃機関における窒素酸化物（ＮＯｘ）の発生量を十分に低減することができなくなる場合がある。

【００１６】本発明は、上記したような種々の問題に鑑みてなされたものであり、内燃機関の排気エミッションの悪化防止に寄与することを目的とする。

【００１７】

【課題を解決するための手段】本発明は、上記した課題を解決するために以下のような手段を採用した。

【００１８】すなわち、本発明に係る内燃機関の排気浄化装置は、内燃機関の吸気系に排気の一部を再循環させるＥＧＲ装置と、前記ＥＧＲ装置を再循環するＥＧＲガスを冷却させるＥＧＲクーラと、を具備する内燃機関の排気浄化装置において、前記内燃機関の運転状態を検出する運転状態検出手段と、前記ＥＧＲ装置を再循環するＥＧＲガスの温度を計測するＥＧＲガス温度計測手段と、前記運転状態検出手段により検出された運転状態及び前記ＥＧＲガス温度計測手段により計測されたＥＧＲガスの温度に基づいて前記ＥＧＲクーラの冷却効率を推定するＥＧＲクーラ冷却効率推定手段と、前記内燃機関に吸入される空気の量及びＥＧＲガスの量をパラメータに含み内燃機関に供給する燃料の量を決定する燃料主噴射量決定手段と、前記ＥＧＲクーラ冷却効率と共に変化する内燃機関に吸入される新気の量を前記ＥＧＲクーラ冷却効率推定手段により推定されたＥＧＲクーラ冷却効率に基づいて補正する吸入新気量補正手段と、前記ＥＧＲクーラ冷却効率と共に変化する内燃機関に吸入されるＥＧＲガスの量を前記ＥＧＲクーラ冷却効率推定手段により推定されたＥＧＲクーラ冷却効率に基づいて補正するＥＧＲガス量補正手段と、を具備した。

【００１９】前記ＥＧＲクーラ冷却効率推定手段は、予め求められたＥＧＲクーラの冷却効率とＥＧＲクーラを通過した後のＥＧＲガス温度との相関関係に基づいてＥＧＲ冷却効率を算出することができる。

【００２０】このように構成された内燃機関の排気浄化装置では、内燃機関から排出された排気の一部を吸気系に再循環し、再循環ガス（ＥＧＲガス）は新気と共に燃焼室に吸入される。ＥＧＲガスは自ら燃焼することはなく、燃焼温度を低下させる働きをし、以て窒素酸化物（ＮＯｘ）の発生量が抑制される。

【００２１】ＥＧＲクーラは、ＥＧＲガスと冷媒との間で熱交換を行いＥＧＲガスを冷却するものである。ＥＧＲガスが冷却されると、ＥＧＲガスの体積が縮小されるため、ＥＧＲガスが燃焼室内に供給されたときに該燃焼室内の雰囲気温度が不要に上昇することがなくなるとともに、燃焼室内に供給される新気の量が不要に減少されることがない。

【００２２】しかし、ＥＧＲクーラに詰まりが発生した場合は、詰まりが発生していない場合に比してＥＧＲクーラにおける熱交換効率が低下する。

【００２３】一方、所定の運転状態における代表的な状態（例えば新品状態）のＥＧＲクーラを通過した後のＥＧＲガスの温度は、その運転状態に応じた一定の温度となる。

【００２４】そこで、ある運転条件下である代表的な状態のＥＧＲクーラを通過した後のＥＧＲガスの温度とＥＧＲクーラを通過する前のＥＧＲガスの温度とを予め実験で求めておけば、ＥＧＲガス温度とＥＧＲクーラの効率との関係を導くことができる。

【００２５】この関係を用いて、ＥＧＲクーラ冷却効率推定手段はＥＧＲクーラ通過後の排気の温度をパラメータとしてＥＧＲクーラの効率を推定することができる。

【００２６】前記吸入新気量補正手段及び前記ＥＧＲガス量補正手段は、吸気絞り弁及びＥＧＲ制御弁とその制御装置とを例示することができ、ＥＧＲクーラの冷却効率に基づいて開弁率を変更し、内燃機関の燃焼室に吸入される新気量及びＥＧＲガス量を補正することができる。

【００２７】上記したＥＧＲクーラとしては、大気とＥＧＲガスとの間で熱交換を行う空冷式のクーラや、所定の冷却水とＥＧＲガスとの間で熱交換を行う水冷式のクーラを例示することができる。所定の冷却水は、内燃機

関用の冷却水でもよいし、ＥＧＲガスのみを冷却するための専用の冷却水であってもよい。

【００２８】

【発明の実施の形態】以下、本発明に係る内燃機関の排気浄化装置の具体的な実施態様について図面に基づいて説明する。ここでは、本発明に係る排気浄化装置を車両駆動用のディーゼル機関に適用した場合を例に挙げて説明する。

【００２９】図１は、本発明に係る排気浄化装置を適用する内燃機関とその吸排気系の概略構成を示す図である。

【００３０】図１に示す内燃機関１は、４つの気筒２を有する水冷式の４ストローク・ディーゼル機関である。

【００３１】内燃機関１は、各気筒２の燃焼室に直接燃料を噴射する燃料噴射弁３を備えている。各燃料噴射弁３は、燃料を所定圧まで蓄圧する蓄圧室（コモンレール）４と接続されている。このコモンレール４には、該コモンレール４内の燃料の圧力に対応した電気信号を出力するコモンレール圧センサ４ａが取り付けられている。

【００３２】前記コモンレール４は、燃料供給管５を介して燃料ポンプ６と連通している。この燃料ポンプ６は、内燃機関１の出力軸（クランクシャフト）の回転トルクを駆動源として作動するポンプであり、該燃料ポンプ６の入力軸に取り付けられたポンププーリ６が内燃機関１の出力軸（クランクシャフト）に取り付けられたクランクプーリ１ａとベルト７を介して連結されている。

【００３３】このように構成された燃料噴射系では、クランクシャフトの回転トルクが燃料ポンプ６の入力軸へ伝達されると、燃料ポンプ６は、クランクシャフトから該燃料ポンプ６の入力軸へ伝達された回転トルクに応じた圧力で燃料を吐出する。

【００３４】前記燃料ポンプ６から吐出された燃料は、燃料供給管５を介してコモンレール４へ供給され、コモンレール４にて所定圧まで蓄圧されて各気筒２の燃料噴射弁３へ分配される。そして、燃料噴射弁３に駆動電流が印加されると、燃料噴射弁３が開弁し、その結果、燃料噴射弁３から気筒２内へ燃料が噴射される。

【００３５】次に、内燃機関１には、吸気枝管８が接続されており、吸気枝管８の各枝管は、各気筒２の燃焼室と図示しない吸気ポートを介して連通している。

【００３６】前記吸気枝管８は、吸気管９に接続され、この吸気管９は、エアクリーナボックス１０に接続されている。前記エアクリーナボックス１０より下流の吸気管９には、該吸気管９内を流れる吸気の質量に対応した電気信号を出力するエアフローメータ１１と、該吸気管９内を流れる吸気の温度に対応した電気信号を出力する吸気温度センサ１２とが取り付けられている。

【００３７】前記吸気管９における吸気枝管８の直上流に位置する部位には、該吸気管９内を流れる吸気の流量を調節する吸気絞り弁１３が設けられている。この吸気絞り弁１３には、ステッパモータ等で構成されて該吸気絞り弁１３を開閉駆動する吸気絞り用アクチュエータ１４が取り付けられている。

【００３８】前記エアフローメータ１１と前記吸気絞り弁１３との間に位置する吸気管９には、排気の熱エネルギを駆動源として作動する遠心過給機（ターボチャージャ）１５のコンプレッサハウジング１５ａが設けられ、コンプレッサハウジング１５ａより下流の吸気管９には、前記コンプレッサハウジング１５ａ内で圧縮されて高温となった吸気を冷却するためのインタークーラ１６が設けられている。

【００３９】このように構成された吸気系では、エアクリーナボックス１０に流入した吸気は、該エアクリーナボックス１０内の図示しないエアクリーナによって吸気中の塵や埃等が除去された後、吸気管９を介してコンプレッサハウジング１５ａに流入する。

【００４０】コンプレッサハウジング１５ａに流入した吸気は、該コンプレッサハウジング１５ａに内装されたコンプレッサホイールの回転によって圧縮される。前記コンプレッサハウジング１５ａ内で圧縮されて高温となった吸気は、インタークーラ１６にて冷却された後、必要に応じて吸気絞り弁１３によって流量を調節されて吸気枝管８に流入する。吸気枝管８に流入した吸気は、各枝管を介して各気筒２の燃焼室へ分配され、各気筒２の燃料噴射弁３から噴射された燃料を着火源として燃焼される。

【００４１】一方、内燃機関１には、排気枝管１８が接続され、排気枝管１８の各枝管が図示しない排気ポートを介して各気筒２の燃焼室と連通している。

【００４２】前記排気枝管１８は、前記遠心過給機１５のタービンハウジング１５ｂと接続されている。前記タービンハウジング１５ｂは、排気管１９と接続され、この排気管１９は、下流にて図示しないマフラーに接続されている。

【００４３】前記排気管１９の途中には、排気中の有害ガス成分を浄化するための排気浄化触媒２０が配置されている。排気浄化触媒２０より下流の排気管１９には、該排気管１９内を流れる排気の空燃比に対応した電気信号を出力する空燃比センサ２３と、該排気管１９内を流れる排気の温度に対応した電気信号を出力する排気温度センサ２４とが取り付けられている。

【００４４】前記した空燃比センサ２３及び排気温度センサ２４より下流の排気管１９には、該排気管１９内を流れる排気の流量を調節する排気絞り弁２１が設けられている。この排気絞り弁２１には、ステッパモータ等で構成されて該排気絞り弁２１を開閉駆動する排気絞り用アクチュエータ２２が取り付けられている。

【００４５】このように構成された排気系では、内燃機関１の各気筒２で燃焼された混合気（既燃ガス）が排気

ポートを介して排気枝管１８へ排出され、次いで排気枝管１８から遠心過給機１５のタービンハウジング１５ｂへ流入する。タービンハウジング１５ｂに流入した排気は、該排気が持つ熱エネルギを利用してタービンハウジング１５ｂ内に回転自在に支持されたタービンホイールを回転させる。その際、タービンホイールの回転トルクは、前述したコンプレッサハウジング１５ａのコンプレッサホイールへ伝達される。

【００４６】前記タービンハウジング１５ｂから排出された排気は、排気管１９を介して排気浄化触媒２０へ流入し、排気中の有害ガス成分が除去又は浄化される。排気浄化触媒２０にて有害ガス成分を除去又は浄化された排気は、必要に応じて排気絞り弁２１によって流量を調節された後にマフラーを介して大気中に放出される。

【００４７】また、排気枝管１８と吸気枝管８とは、排気枝管１８内を流れる排気の一部を吸気枝管８へ再循環させる排気再循環通路（ＥＧＲ通路）２５を介して連通されている。このＥＧＲ通路２５の途中には、電磁弁などで構成され、印加電力の大きさに応じて前記ＥＧＲ通路２５内を流れる排気（以下、ＥＧＲガスと称する）の流量を変更する流量調整弁（ＥＧＲ弁）２６が設けられている。

【００４８】前記ＥＧＲ弁２６には、該ＥＧＲ弁２６の開度に対応した電気信号を出力するＥＧＲ開度センサ３８が取り付けられている。このＥＧＲ開度センサ３８としては、例えば、ＥＧＲ弁２６の開閉動作に連動して抵抗体上を摺動する金属接点を備えたポテンショメータや、ＥＧＲ弁２６の開閉動作に連動して回転するスロットディスクと、スロットディスクを介して対向するよう配置されたＬＥＤ及びフォトトランジスタからなるフォトインタラプタとを備えたフォトインタラプタ方式のセンサ等を例示することができる。

【００４９】前記ＥＧＲ通路２５においてＥＧＲ弁２６より上流の部位には、該ＥＧＲ通路２５内を流れるＥＧＲガスを冷却するＥＧＲクーラ２７が設けられている。

【００５０】このように構成された排気再循環機構では、ＥＧＲ弁２６が開弁されると、ＥＧＲ通路２５が導通状態となり、排気枝管１８内を流れる排気の一部が前記ＥＧＲ通路２５へ流入し、ＥＧＲクーラ２７を経て吸気枝管８へ導かれる。

【００５１】その際、ＥＧＲクーラ２７では、ＥＧＲ通路２５内を流れるＥＧＲガスと所定の冷媒との間で熱交換が行われ、ＥＧＲガスが冷却されることになる。

【００５２】ＥＧＲ通路２５を介して排気枝管１８から吸気枝管８へ還流されたＥＧＲガスは、吸気枝管８の上流から流れてきた新気と混ざり合いつつ各気筒２の燃焼室へ導かれ、燃料噴射弁３から噴射される燃料を着火源として燃焼される。

【００５３】ここで、ＥＧＲガスには、水（H_2O）や二酸化炭素（CO_2）などのように、自らが燃焼することがなく、且つ、吸熱性を有する不活性ガス成分が含まれているため、ＥＧＲガスが混合気中に含有されると、混合気の燃焼温度が低められ、以て窒素酸化物（ＮＯｘ）の発生量が抑制される。

【００５４】更に、ＥＧＲクーラ２７においてＥＧＲガスが冷却されると、ＥＧＲガス自体の温度が低下するとともにＥＧＲガスの体積が縮小されるため、ＥＧＲガスが燃焼室内に供給されたときに該燃焼室内の雰囲気温度が不要に上昇することがなくなるとともに、燃焼室内に供給される新気の量（新気の体積）が不要に減少することもない。

【００５５】排気浄化触媒２０は、還元剤の存在下で排気中の窒素酸化物（ＮＯｘ）を浄化するＮＯｘ触媒である。このようなＮＯｘ触媒としては、選択還元型ＮＯｘ触媒や吸蔵還元型ＮＯｘ触媒等を例示することができるが、ここでは吸蔵還元型ＮＯｘ触媒を例に挙げて説明する。以下、排気浄化触媒２０を吸蔵還元型ＮＯｘ触媒２０と称するものとする。

【００５６】吸蔵還元型ＮＯｘ触媒２０は、例えば、アルミナを担体とし、その担体上に、カリウム（Ｋ）、ナトリウム（Ｎａ）、リチウム（Ｌｉ）、もしくはセシウム（Ｃｓ）等のアルカリ金属と、バリウム（Ｂａ）もしくはカルシウム（Ｃａ）等のアルカリ土類と、ランタン（Ｌａ）もしくはイットリウム（Ｙ）等の希土類とから選択された少なくとも１つと、白金（Ｐｔ）等の貴金属とを担持して構成されている。尚、本実施の形態では、アルミナからなる担体上にバリウム（Ｂａ）と白金（Ｐｔ）とを担持して構成される吸蔵還元型ＮＯｘ触媒を例に挙げて説明する。

【００５７】このように構成された吸蔵還元型ＮＯｘ触媒２０は、該吸蔵還元型ＮＯｘ触媒２０に流入する排気の酸素濃度が高いときは排気中の窒素酸化物（ＮＯｘ）を吸収する。

【００５８】一方、吸蔵還元型ＮＯｘ触媒２０は、該吸蔵還元型ＮＯｘ触媒２０に流入する排気の酸素濃度が低下したときは吸収していた窒素酸化物（ＮＯｘ）を放出する。その際、排気中に炭化水素（ＨＣ）や一酸化炭素（ＣＯ）等の還元成分が存在していれば、吸蔵還元型ＮＯｘ触媒２０は、該吸蔵還元型ＮＯｘ触媒２０から放出された窒素酸化物（ＮＯｘ）を窒素（N_2）に還元せしめることができる。

【００５９】尚、吸蔵還元型ＮＯｘ触媒２０のＮＯｘ吸放出作用については明らかにされていない部分もあるが、おおよそ以下のようなメカニズムによって行われていると考えられる。

【００６０】先ず、吸蔵還元型ＮＯｘ触媒２０では、該吸蔵還元型ＮＯｘ触媒２０に流入する排気の空燃比がリーン空燃比となって排気中の酸素濃度が高まると、図２（Ａ）に示されるように、排気中の酸素（O_2）がO_2^-またはO^{2-}の形で白金（Ｐｔ）の表面上に付着する。排

気中の一酸化窒素（ＮＯ）は、白金（Ｐｔ）の表面上でO_2^-またはO^{2-}と反応して二酸化窒素（NO_2）を形成する（$2NO+O_2 \rightarrow 2NO_2$）。二酸化窒素（$NO_2$）は、白金（Ｐｔ）の表面上で更に酸化され、硝酸イオン（NO_3^-）の形で吸蔵還元型ＮＯｘ触媒２０に吸収される。尚、吸蔵還元型ＮＯｘ触媒２０に吸収された硝酸イオン（NO_3^-）は、酸化バリウム（ＢａＯ）と結合して硝酸バリウム（$Ba(NO_3)_2$）を形成する。

【００６１】このように吸蔵還元型ＮＯｘ触媒２０に流入する排気の空燃比がリーン空燃比であるときは、排気中の窒素酸化物（ＮＯｘ）が硝酸イオン（NO_3^-）として吸蔵還元型ＮＯｘ触媒２０に吸収される。

【００６２】上記したようなＮＯｘ吸収作用は、流入排気の空燃比がリーン空燃比であり、且つ吸蔵還元型ＮＯｘ触媒２０のＮＯｘ吸収能力が飽和しない限り継続される。従って、吸蔵還元型ＮＯｘ触媒２０に流入する排気の空燃比がリーン空燃比であるときは、吸蔵還元型ＮＯｘ触媒２０のＮＯｘ吸収能力が飽和しない限り、排気中の窒素酸化物（ＮＯｘ）が吸蔵還元型ＮＯｘ触媒２０に吸収され、排気中から窒素酸化物（ＮＯｘ）が除去されることになる。

【００６３】これに対して、吸蔵還元型ＮＯｘ触媒２０では、該吸蔵還元型ＮＯｘ触媒２０に流入する排気の酸素濃度が低下すると、白金（Ｐｔ）の表面上において二酸化窒素（NO_2）の生成量が減少するため、酸化バリウム（ＢａＯ）と結合していた硝酸イオン（NO_3^-）が逆に二酸化窒素（NO_2）や一酸化窒素（ＮＯ）となって吸蔵還元型ＮＯｘ触媒２０から離脱する。

【００６４】その際、排気中に炭化水素（ＨＣ）や一酸化炭素（ＣＯ）等の還元成分が存在していれば、それらの還元成分が白金（Ｐｔ）上の酸素（O_2^-またはO^{2-}）と部分的に反応して活性種を形成する。この活性種は、吸蔵還元型ＮＯｘ触媒２０から放出された二酸化窒素（NO_2）や一酸化窒素（ＮＯ）を窒素（N_2）に還元せしめることになる。

【００６５】従って、吸蔵還元型ＮＯｘ触媒２０に流入する排気の空燃比が理論空燃比又はリッチ空燃比となって排気中の酸素濃度が低下するとともに還元剤の濃度が高まると、吸蔵還元型ＮＯｘ触媒２０に吸収されていた窒素酸化物（ＮＯｘ）が放出及び還元され、以て吸蔵還元型ＮＯｘ触媒２０のＮＯｘ吸収能力が再生されることになる。

【００６６】ところで、内燃機関１が希薄燃焼運転されている場合は、内燃機関１から排出される排気の空燃比がリーン雰囲気となり排気の酸素濃度が高くなるため、排気中に含まれる窒素酸化物（ＮＯｘ）が吸蔵還元型ＮＯｘ触媒２０に吸収されることになるが、内燃機関１の希薄燃焼運転が長期間継続されると、吸蔵還元型ＮＯｘ触媒２０のＮＯｘ吸収能力が飽和し、排気中の窒素酸化物（ＮＯｘ）が吸蔵還元型ＮＯｘ触媒２０にて除去されずに大気中へ放出されてしまう。

【００６７】特に、内燃機関１のようなディーゼル機関では、大部分の運転領域においてリーン空燃比の混合気が燃焼され、それに応じて大部分の運転領域において排気の空燃比がリーン空燃比となるため、吸蔵還元型ＮＯｘ触媒２０のＮＯｘ吸収能力が飽和し易い。

【００６８】従って、内燃機関１が希薄燃焼運転されている場合は、吸蔵還元型ＮＯｘ触媒２０のＮＯｘ吸収能力が飽和する前に吸蔵還元型ＮＯｘ触媒２０に流入する排気中の酸素濃度を低下させるとともに還元剤の濃度を高め、吸蔵還元型ＮＯｘ触媒２０に吸収された窒素酸化物（ＮＯｘ）を放出及び還元させる必要がある。

【００６９】これに対し、本実施の形態に係る内燃機関の排気浄化装置は、吸蔵還元型ＮＯｘ触媒２０より上流の排気通路を流れる排気中に還元剤たる燃料（軽油）を添加する還元剤供給機構を備え、この還元剤供給機構から排気中へ燃料を添加することにより、吸蔵還元型ＮＯｘ触媒２０に流入する排気の酸素濃度を低下させるとともに還元剤の濃度を高めるようにした。

【００７０】還元剤供給機構は、図１に示されるように、その噴孔が排気枝管１８内に臨むよう内燃機関１のシリンダヘッドに取り付けられ、所定の開弁圧以上の燃料が印加されたときに開弁して燃料を噴射する還元剤噴射弁２８と、前述した燃料ポンプ６から吐出された燃料を前記還元剤噴射弁２８へ導く還元剤供給路２９と、この還元剤供給路２９の途中に設けられ該還元剤供給通路２９内を流れる燃料の流量を調整する流量調整弁３０と、この流量調整弁３０より上流の還元剤供給路２９に設けられて該還元剤供給路２９内の燃料の流れを遮断する遮断弁３１と、前記流量調整弁３０より上流の還元剤供給路２９に取り付けられ該還元剤供給路２９内の圧力に対応した電気信号を出力する還元剤圧力センサ３２と、を備えている。

【００７１】尚、還元剤噴射弁２８は、該還元剤噴射弁２８の噴孔が排気枝管１８におけるＥＧＲ通路２５との接続部位より下流であって、排気枝管１８における４つの枝管の集合部に最も近い気筒２の排気ポートに突出するとともに、排気枝管１８の集合部へ向くようシリンダヘッドに取り付けられることが好ましい。

【００７２】これは、還元剤噴射弁２８から噴射された還元剤（未燃の燃料成分）がＥＧＲ通路２５へ流入しＥＧＲクーラの目詰まりの原因になったり、吸気と混合し空燃比が小さくなるのを防止するとともに、還元剤が排気枝管１８内に滞ることなく遠心過給機のタービンハウジング１５ｂへ到達するようにするためである。

【００７３】尚、図１に示す例では、内燃機関１の４つの気筒２のうち１番（＃１）気筒２が排気枝管１８の集合部と最も近い位置にあるため、１番（＃１）気筒２の排気ポートに還元剤噴射弁２８が取り付けられているが、１番（＃１）気筒２以外の気筒２が排気枝管１８の

集合部と最も近い位置にあるときは、その気筒2の排気ポートに還元剤噴射弁28が取り付けられるようにする。

【0074】また、前記還元剤噴射弁28は、シリンダヘッドに形成された図示しないウォータージャケットを貫通、あるいはウォータージャケットに近接して取り付けられるようにし、前記ウォータージャケットを流れる冷却水を利用して還元剤噴射弁28を冷却するようにしてもよい。

【0075】このような還元剤供給機構では、流量調整弁30が開弁されると、燃料ポンプ6から吐出された高圧の燃料が還元剤供給路29を介して還元剤噴射弁28へ印加される。そして、還元剤噴射弁28に印加される燃料の圧力が開弁圧以上に達すると、該還元剤噴射弁28が開弁して排気枝管18内へ還元剤としての燃料が噴射される。

【0076】還元剤噴射弁28から排気枝管18内へ噴射された還元剤は、排気枝管18の上流から流れてきた排気とともにタービンハウジング15bへ流入する。タービンハウジング15b内に流入した排気と還元剤とは、タービンホイールの回転によって撹拌されて均質に混合され、リッチ空燃比の排気を形成する。

【0077】このようにして形成されたリッチ空燃比の排気は、タービンハウジング15bから排気管19を介して吸蔵還元型NOx触媒20に流入し、吸蔵還元型NOx触媒20に吸収されていた窒素酸化物（NOx）を放出させつつ窒素（N_2）に還元することになる。

【0078】その後、流量調整弁30が閉弁されて燃料ポンプ6から還元剤噴射弁28への還元剤の供給が遮断されると、還元剤噴射弁28に印加される燃料の圧力が前記開弁圧未満となり、その結果、還元剤噴射弁28が閉弁し、排気枝管18内への還元剤の添加が停止されることになる。

【0079】以上述べたように構成された内燃機関1には、該内燃機関1を制御するための電子制御ユニット（ECU：Electronic Control Unit）35が併設されている。このECU35は、内燃機関1の運転条件や運転者の要求に応じて内燃機関1の運転状態を制御するユニットである。

【0080】ECU35には、コモンレール圧センサ4a、エアフローメータ11、吸気温度センサ12、吸気管圧力センサ17、空燃比センサ23、排気温度センサ24、還元剤圧力センサ32、クランクポジションセンサ33、水温センサ34、アクセル開度センサ36、EGR開度センサ38、EGRガス温度センサ37等の各種センサが電気配線を介して接続され、上記した各種センサの出力信号がECU35に入力されるようになっている。

【0081】一方、ECU35には、燃料噴射弁3、吸気絞り用アクチュエータ14、排気絞り用アクチュエータ22、EGR弁26、流量調整弁30、遮断弁31等が電気配線を介して接続され、上記した各部をECU35が制御することが可能になっている。

【0082】ここで、ECU35は、図3に示すように、双方向性バス350によって相互に接続された、CPU351と、ROM352と、RAM353と、バックアップRAM354と、入力ポート356と、出力ポート357とを備えるとともに、前記入力ポート356に接続されたA／Dコンバータ（A／D）355を備えている。

【0083】前記入力ポート356は、クランクポジションセンサ33のようにデジタル信号形式の信号を出力するセンサの出力信号を入力し、それらの出力信号をCPU351やRAM353へ送信する。

【0084】前記入力ポート356は、コモンレール圧センサ4a、エアフローメータ11、吸気温度センサ12、吸気管圧力センサ17、空燃比センサ23、排気温度センサ24、還元剤圧力センサ32、水温センサ34、アクセル開度センサ36、EGR開度センサ38、EGRガス温度センサ37等のように、アナログ信号形式の信号を出力するセンサのA／D355を介して入力し、それらの出力信号をCPU351やRAM353へ送信する。

【0085】前記出力ポート357は、燃料噴射弁3、吸気絞り用アクチュエータ14、排気絞り用アクチュエータ22、EGR弁26、流量調整弁30、遮断弁31等と電気配線を介して接続され、CPU351から出力される制御信号を、前記した燃料噴射弁3、吸気絞り用アクチュエータ14、排気絞り用アクチュエータ22、EGR弁26、流量調整弁30、あるいは遮断弁31へ送信する。

【0086】前記ROM352は、燃料噴射弁3を制御するための燃料噴射制御ルーチン、吸気絞り弁13を制御するための吸気絞り制御ルーチン、排気絞り弁21を制御するための排気絞り制御ルーチン、EGR弁26を制御するためのEGR制御ルーチン、吸蔵還元型NOx触媒20に吸収された窒素酸化物（NOx）を浄化するためのNOx浄化制御ルーチン、吸蔵還元型NOx触媒20の酸化物による被毒を解消するための被毒解消制御ルーチン等のアプリケーションプログラムを記憶している。

【0087】前記ROM352は、上記したアプリケーションプログラムに加え、各種の制御マップを記憶している。前記制御マップは、例えば、内燃機関1の運転状態と基本燃料噴射量（基本燃料噴射時間）との関係を示す燃料噴射量制御マップ、内燃機関1の運転状態と基本燃料噴射時期との関係を示す燃料噴射時期制御マップ、内燃機関1の運転状態と吸気絞り弁13の目標開度との関係を示す吸気絞り弁開度制御マップ、EGRクーラ27の冷却効率と吸入新気量との関係を示す吸入新気量補

正マップ、内燃機関１の運転状態と排気絞り弁２１の目標開度との関係を示す排気絞り弁開度制御マップ、内燃機関１の運転状態とＥＧＲ弁２６の目標開度との関係を示すＥＧＲ弁開度制御マップ、ＥＧＲクーラ２７の冷却効率と必要ＥＧＲ量との関係を示すＥＧＲガス量補正マップ、ＥＧＲガス温度とＥＧＲクーラ２７の冷却効率との関係を示すＥＧＲクーラ効率推定マップ、内燃機関１の運転状態と還元剤の目標添加量（もしくは、排気の目標空燃比）との関係を示す還元剤添加量制御マップ、還元剤の目標添加量と流量調整弁３０の開弁時間との関係を示す流量調整弁制御マップ等である。

【００８８】前記ＲＡＭ３５３は、各センサからの出力信号やＣＰＵ３５１の演算結果等を格納する。前記演算結果は、例えば、クランクポジションセンサ３３がパルス信号を出力する時間的な間隔に基づいて算出される機関回転数である。これらのデータは、クランクポジションセンサ３３がパルス信号を出力する都度、最新のデータに書き換えられる。

【００８９】前記バックアップＲＡＭ３５４は、内燃機関１の運転停止後もデータを記憶可能な不揮発性のメモリである。

【００９０】前記ＣＰＵ３５１は、前記ＲＯＭ３５２に記憶されたアプリケーションプログラムに従って動作して、燃料噴射弁制御、吸気絞り制御、排気絞り制御、ＥＧＲ制御、ＮＯx浄化制御、被毒解消制御、ＥＧＲクーラ冷却効率推定制御を実行する。

【００９１】例えば、燃料噴射弁制御では、ＣＰＵ３５１は、先ず、燃料噴射弁３から噴射される燃料量を決定し、次いで燃料噴射弁３から燃料を噴射する時期を決定する。

【００９２】燃料噴射量を決定する場合は、ＣＰＵ３５１は、ＲＡＭ３５３に記憶されている機関回転数とアクセル開度センサ３６の出力信号（アクセル開度）とを読み出す。ＣＰＵ３５１は、燃料噴射量制御マップへアクセスし、前記機関回転数及び前記アクセル開度に対応した基本燃料燃料噴射量（基本燃料噴射時間）を算出する。ＣＰＵ３５１は、エアフローメータ１１、吸気温度センサ１２、水温センサ３４等の出力信号値等に基づいて前記基本燃料噴射時間を補正し、最終的な燃料噴射時間を決定する。

【００９３】燃料噴射時期を決定する場合は、ＣＰＵ３５１は、燃料噴射開始時期制御マップへアクセスし、前記機関回転数及び前記アクセル開度に対応した基本燃料噴射時期を算出する。ＣＰＵ３５１は、エアフローメータ１１、吸気温度センサ１２、水温センサ３４等の出力信号値をパラメータとして前記基本燃料噴射時期を補正し、最終的な燃料噴射時期を決定する。

【００９４】燃料噴射時間と燃料噴射時期とが決定されると、ＣＰＵ３５１は、前記燃料噴射時期とクランクポジションセンサ３３の出力信号とを比較し、前記クランクポジションセンサ３３の出力信号が前記燃料噴射開始時期と一致した時点で燃料噴射弁３に対する駆動電力の印加を開始する。ＣＰＵ３５１は、燃料噴射弁３に対する駆動電力の印加を開始した時点からの経過時間が前記燃料噴射時間に達した時点で燃料噴射弁３に対する駆動電力の印加を停止する。

【００９５】尚、燃料噴射制御において内燃機関１の運転状態がアイドル運転状態にある場合は、ＣＰＵ３５１は、水温センサ３４の出力信号値や、車室内用空調装置のコンプレッサのようにクランクシャフトの回転力を利用して作動する補機類の作動状態等をパラメータとして内燃機関１の目標アイドル回転数を算出する。そして、ＣＰＵ３５１は、実際のアイドル回転数が目標アイドル回転数と一致するよう燃料噴射量をフィードバック制御する。

【００９６】また、吸気絞り制御では、ＣＰＵ３５１は、例えば、ＲＡＭ３５３に記憶されている機関回転数とアクセル開度とを読み出す。ＣＰＵ３５１は、吸気絞り弁開度制御マップへアクセスし、機関回転数及びアクセル開度に対応した目標吸気絞り弁開度を算出する。ＣＰＵ３５１は、前記目標吸気絞り弁開度に対応した駆動電力を吸気絞り用アクチュエータ１４に印加する。その際、ＣＰＵ３５１は、吸気絞り弁１３の実際の開度を検出して、実際の吸気絞り弁１３の開度と目標吸気絞り弁開度との差分に基づいて前記吸気絞り用アクチュエータ１４をフィードバック制御するようにしてもよい。

【００９７】また、排気絞り制御では、ＣＰＵ３５１は、例えば、内燃機関１が冷間始動後の暖機運転状態にある場合や、車室内用ヒータが作動状態にある場合などに排気絞り弁２１を閉弁方向へ駆動すべく排気絞り用アクチュエータ２２を制御する。

【００９８】この場合、内燃機関１の負荷が増大し、それに対応して燃料噴射量が増量されることなる。その結果、内燃機関１の発熱量が増加し、内燃機関１の暖機が促進されるとともに、車室内用ヒータの熱源が確保される。

【００９９】また、ＥＧＲ制御では、ＣＰＵ３５１は、ＲＡＭ３５３に記憶されている機関回転数、水温センサ３４の出力信号（冷却水温度）、アクセル開度センサ３６の出力信号（アクセル開度）等を読み出し、ＥＧＲ制御の実行条件が成立しているか否かを判別する。

【０１００】上記したＥＧＲ制御実行条件としては、冷却水温度が所定温度以上にある、内燃機関１が始動時から所定時間以上連続して運転されている、アクセル開度の変化量が正値である等の条件を例示することができる。

【０１０１】上記したようなＥＧＲ制御実行条件が成立していると判定した場合は、ＣＰＵ３５１は、機関回転数とアクセル開度とをパラメータとしてＥＧＲ弁開度制御マップへアクセスし、前記機関回転数及び前記アクセ

ル開度に対応した目標ＥＧＲ弁開度を算出する。ＣＰＵ３５１は、前記目標ＥＧＲ弁開度に対応した駆動電力をＥＧＲ弁２６に印加する。一方、上記したようなＥＧＲ制御実行条件が成立していないと判定した場合は、ＣＰＵ３５１は、ＥＧＲ弁２６を全閉状態に保持すべく制御する。

【０１０２】次に、本実施の形態に係るＥＧＲ制御について説明する。

【０１０３】本実施の形態に係るＥＧＲ制御では、ＣＰＵ３５１は、内燃機関１の吸入新気量をパラメータとしてＥＧＲ弁２６の開度をフィードバック制御する、いわゆるＥＧＲ弁フィードバック制御を行う。

【０１０４】ＥＧＲ弁フィードバック制御では、例えば、ＣＰＵ３５１は、アクセル開度や機関回転数等をパラメータとして内燃機関１の目標吸入新気量を決定する。その際、アクセル開度と機関回転数と目標吸入新気量との関係を予めマップ化しておき、そのマップとアクセル開度と機関回転数とから目標吸入新気量が算出される。

【０１０５】ここで、ＥＧＲクーラに詰まりが発生した場合は、詰まりが発生していない場合に比してＥＧＲクーラにおける熱交換効率が低下し、ＥＧＲガス温度が上昇するため、エミッションの要求からＥＧＲクーラの冷却効率に合わせてＥＧＲガス量及び吸入新気量を変化させなくてはならない。

【０１０６】即ち、ＥＧＲクーラの冷却効率が低下していると、気筒２に吸入されるＥＧＲガスの冷却が不十分になり、気筒２の雰囲気温度が高くなるのでＥＧＲガスの密度は小さくなる。これにより、エミッションの要求を満たすためには、より多くのＥＧＲガスを気筒２へ供給しなくてはならなくなる。このような関係は図５に示すように、機関負荷毎にＥＧＲクーラ効率と必要ＥＧＲガス量との相関関係として示すことができる。

【０１０７】一方、ＥＧＲクーラの冷却効率が低いほど気筒２に吸入される新気の温度が上昇し充填効率が低下するので、気筒２へ吸入される新気の量を増加させる。このような関係は、図６に示すように、機関負荷毎にＥＧＲクーラ効率と吸入新気量との相関関係として示すことができる。

【０１０８】エミッションの悪化を防止するためには、ＥＧＲガス量及び吸入新気量を補正しその時の運転状態に見合った適正なＥＧＲガス量と吸入新気量を気筒２に吸入させる必要がある。この補正方法を以下に示す。

【０１０９】所定の運転状態においては、排気の温度と新品状態のＥＧＲクーラ２７を通過した後のＥＧＲガスの温度とは、その運転状態に応じた一定の温度となるため、新品状態のＥＧＲクーラ２７を通過した後のＥＧＲガスの温度とＥＧＲクーラ２７を通過する前のＥＧＲガスの温度とを予め実験で求めておけば、図４に示すようなＥＧＲガス温度とＥＧＲクーラ２７の冷却効率との関係を導くことができる。

【０１１０】この関係をＥＧＲクーラ効率推定マップとしてＲＯＭ３５２に予め記憶させておけば、ＥＧＲガス温度センサ３７の出力信号から得られたＥＧＲクーラ２７通過後のＥＧＲガスの温度をパラメータとしてＥＧＲクーラ２７の効率が推定される。

【０１１１】また、図５により、現時点でのＥＧＲクーラ冷却効率から必要なＥＧＲガス量を算出することができる。この算出された必要なＥＧＲガス量は、ＲＡＭ３５３に記憶される。この必要なＥＧＲガス量が得られるＥＧＲ弁２６及び吸気絞り弁１３の開弁変化量を予め実験により求めてマップ化しＲＯＭ３５２に記憶させておけば、必要なＥＧＲガス量に基づいてＥＧＲ弁２６及び吸気絞り弁１３の開弁補正量を算出することができる。

【０１１２】ＣＰＵ３５１は、前記算出された開弁補正量に基づいてＥＧＲ弁２６及び吸気絞り弁１３の開弁量を変更しＥＧＲガス量及び吸入新気量を補正することができる。

【０１１３】一方、図６により、現時点でのＥＧＲクーラ冷却効率から吸入新気量を算出することができる。この算出された吸入新気量は、ＲＡＭ３５３に記憶される。同時に算出された吸入新気量は補正目標吸入新気量としてＲＡＭ３５３に記憶される。

【０１１４】上記した手順により補正目標吸入新気量が決定されると、ＣＰＵ３５１は、ＲＡＭ３５３に記憶されたエアフローメータ１１の出力信号値（実際の吸入新気量）を読み出し、実際の吸入新気量と補正目標吸入新気量とを比較する。

【０１１５】前記した実際の吸入新気量が補正目標吸入新気量より少ない場合には、ＣＰＵ３５１は、ＥＧＲ弁２６を所定量閉弁させ、吸気絞り弁１３を所定量開弁させる。この場合、ＥＧＲ通路２５から吸気枝管８へ流入するＥＧＲガス量が減少し、それに応じて内燃機関１の気筒２内に吸入されるＥＧＲガス量が減少することになる。その結果、内燃機関１の気筒２内に吸入される新気の量は、ＥＧＲガスが減少した分だけ増加する。

【０１１６】一方、実際の吸入新気量が補正目標吸入新気量より多い場合には、ＣＰＵ３５１は、ＥＧＲ弁２６を所定量開弁させ、吸気絞り弁１３を所定量閉弁させる。この場合、ＥＧＲ通路２５から吸気枝管８へ流入するＥＧＲガス量が増加し、それに応じて内燃機関１の気筒２内に吸入されるＥＧＲガス量が増加する。この結果、内燃機関１の気筒２内に吸入される新気の量は、ＥＧＲガスが増加した分だけ減少することになる。

【０１１７】以上のようにＥＧＲクーラ効率に基づいて吸入新気量の補正とＥＧＲガス量の補正が可能となる。

【０１１８】このようにしてＥＧＲクーラの冷却効率変化に対応した空燃比制御を行うことができ、排気エミッションの悪化を防止することができる。

【０１１９】

【発明の効果】本発明に係る内燃機関の排気浄化装置は、ＥＧＲガス温度からＥＧＲクーラ効率を推定することができ、この推定されたＥＧＲクーラ効率からＥＧＲガス量、吸入新気量を補正することができる。

【０１２０】この結果、ＥＧＲガス量及び吸入新気量を適正化することができ、排気エミッションの悪化を抑制することができる。

【図面の簡単な説明】

【図１】　本発明に係る内燃機関の排気浄化装置を適用する内燃機関とその吸排気系の概略構成を示す図

【図２】　（Ａ）吸蔵還元型ＮＯx触媒のＮＯx吸収メカニズムを説明する図

（Ｂ）吸蔵還元型ＮＯx触媒のＮＯx放出メカニズムを説明する図

【図３】　ＥＣＵの内部構成を示すブロック図

【図４】　ＥＧＲガス温度とＥＧＲクーラ効率との関係を示す図

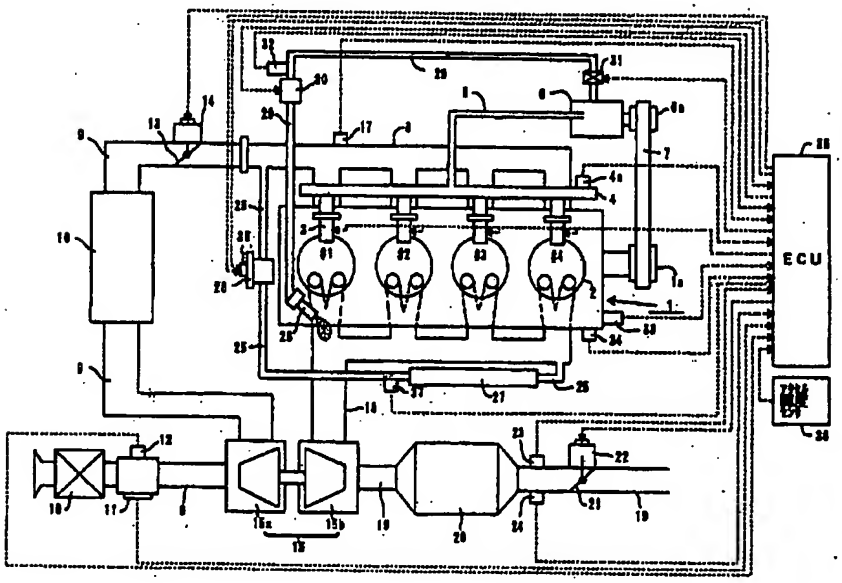
【図５】　ＥＧＲクーラ効率と必要ＥＧＲガス量との関係を示す図

【図６】　ＥＧＲクーラ効率と吸入新気量との関係を示す図

【符号の説明】

１・・・・内燃機関
２・・・・気筒
３・・・・燃料噴射弁
４・・・・コモンレール
５・・・・燃料供給管
６・・・・燃料ポンプ
１８・・・排気枝管
１９・・・排気管
２０・・・吸蔵還元型ＮＯx触媒
２１・・・排気絞り弁
２３・・・空燃比センサ
２５・・・ＥＧＲ通路
２６・・・ＥＧＲ弁
２７・・・ＥＧＲクーラ
２８・・・還元剤噴射弁
２９・・・還元剤供給路
３０・・・流量調整弁
３１・・・遮断弁
３２・・・還元剤圧力センサ
３３・・・クランクポジションセンサ
３４・・・水温センサ
３５・・・ＥＣＵ
３５１・・ＣＰＵ
３５２・・ＲＯＭ
３５３・・ＲＡＭ
３５４・・バックアップＲＡＭ
３７・・・ＥＧＲガス温度センサ
３８・・・ＥＧＲ開度センサ

【図１】



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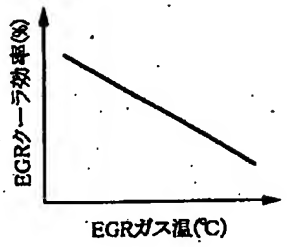

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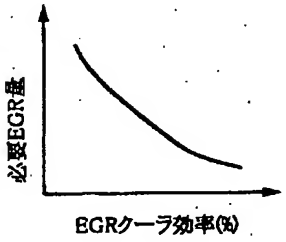

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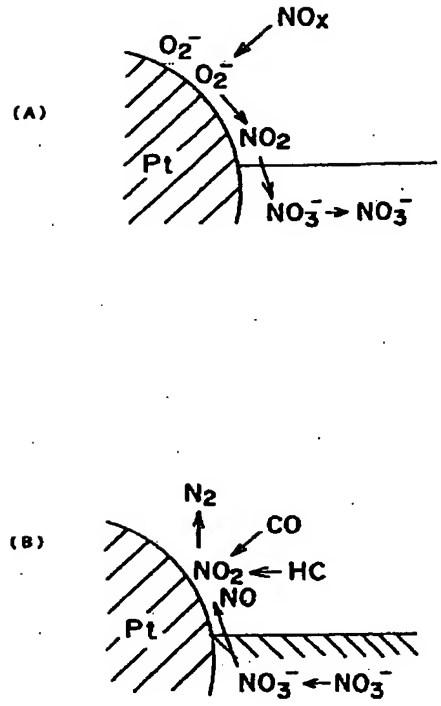

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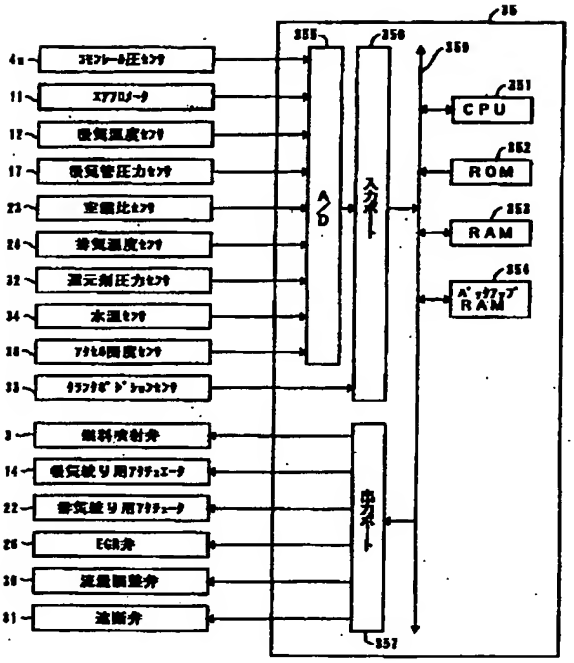

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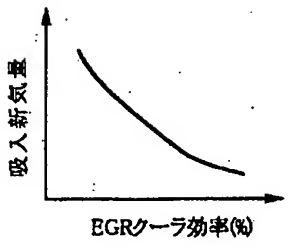

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ABSTRACT:

PROBLEM TO BE SOLVED: To prevent deterioration of the exhaust emission from
an internal combustion engine.

SOLUTION: This exhaust emission control device is provided with an operation
condition-detecting means 36 for an internal combustion engine 1, an EGR gas
temperature-measuring means 37, a means 35 for estimating the cooling
efficiency of an EGR cooler 27 based on the operation condition and EGR gas
temperature, a fuel injection amount-determining means 38 for determining the
fuel amount to be supplied to the engine 1 including the air

amount taken in
the engine 1 and the EGR gas amount in a parameter, a means 14 for correcting
the fresh air amount to be taken in the engine 1 based on the cooling
efficiency of EGR cooler, and a means 26 for correcting the EGR gas amount of
the engine 1 based on the above cooling efficiency.

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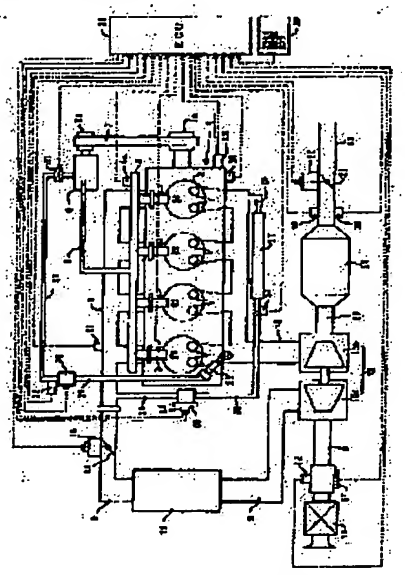
(54) EXHAUST EMISSION CONTROL DEVICE FOR INTERNAL COMBUSTION ENGINE

(57)Abstract:
PROBLEM TO BE SOLVED: To prevent deterioration of the exhaust emission from an internal combustion engine.
SOLUTION: This exhaust emission control device is provided with an operation condition-detecting means 36 for an internal combustion engine 1, an EGR gas temperature-measuring means 37, a means 35 for estimating the cooling efficiency of an EGR cooler 27 based on the operation condition and EGR gas temperature, a fuel injection amount-determining means 38 for determining the fuel amount to be supplied to the engine 1 including the air amount taken in the engine 1 and the EGR gas amount in a parameter, a means 14 for correcting the fresh air amount to be taken in the engine 1 based on the cooling efficiency of EGR cooler, and a means 26 for correcting the EGR gas amount of the engine 1 based on the above cooling efficiency.



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[Date of extinction of right]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] In the exhaust emission control device of the internal combustion engine possessing the EGR equipment which carries out the recirculation of a part of exhaust air to an internal combustion engine's inhalation-of-air system, and the EGR cooler which makes the EGR gas which recycles said EGR equipment cool An operational status detection means to detect said internal combustion engine's operational status, and an EGR gas thermometry means to measure the temperature of the EGR gas which recycles said EGR equipment, An EGR cooler cooling effectiveness presumption means to presume the cooling effectiveness of said EGR cooler based on the temperature of the EGR gas measured by the operational status detected by said operational status detection means, and said EGR gas thermometry means, An amount decision means of fuel main injection to determine the amount of the fuel which contains in a parameter the amount of the air inhaled by said internal combustion engine, and the amount of EGR gas, and is supplied to an internal combustion engine, An inhalation new-air-volume amendment means to amend the amount of the new mind inhaled by the changing internal combustion engine based on the EGR cooler cooling effectiveness presumed by said EGR cooler cooling effectiveness presumption means with said EGR cooler cooling effectiveness, The exhaust emission control device of the internal combustion engine characterized by providing an amount amendment means of EGR gas to amend the amount of the EGR gas inhaled by the changing internal combustion engine based on the EGR cooler cooling effectiveness presumed by said EGR cooler cooling effectiveness presumption means with said EGR cooler cooling effectiveness.
[Claim 2] Said EGR cooler cooling effectiveness presumption means is the exhaust emission control device of the internal combustion engine according to claim 1 characterized by computing EGR cooling effectiveness based on a correlation with the EGR gas temperature after passing the cooling effectiveness of an EGR cooler and the EGR cooler which were called for beforehand.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the exhaust emission control device which purifies an internal combustion engine's exhaust air, especially an exhaust gas recirculation system.
[0002]
[Description of the Prior Art] In recent years, in the internal combustion engine carried in an automobile etc. especially the Diesel engine which enables combustion of the gaseous mixture (the so-called gaseous mixture of the Lean air-fuel ratio) of a hyperoxia condition, or the lean burn gasoline engine, a technique which purifies the nitrogen oxides (NOx) contained during this internal combustion engine's exhaust air is desired.
[0003] The technique which arranges the Lean NOx catalyst in an internal combustion engine's exhaust air system is proposed to such a demand. The occlusion reduction type NOx catalyst which returns to nitrogen (N2) is known emitting the nitrogen oxides (NOx) which were being absorbed, when the nitrogen oxides (NOx) under exhaust air are absorbed when the oxygen density of the flowing exhaust air is high as one of the Lean NOx catalysts, the oxygen density of the flowing exhaust air falls and a reducing agent exists.
[0004] It is returned to nitrogen (N2), the nitrogen oxides (NOx) absorbed by the occlusion reduction type NOx catalyst being emitted when the air-fuel ratio of exhaust air which the nitrogen oxides (NOx) under exhaust air are absorbed by the occlusion reduction type NOx catalyst, and flows into an occlusion reduction type NOx catalyst becomes low when lean combustion operation of the internal combustion engine is carried out and the air-fuel ratio of exhaust air becomes high, if an occlusion reduction type NOx catalyst is arranged at an internal combustion engine's exhaust air system.
[0005] By the way, since there is a limitation in the NOx absorptance of an occlusion reduction type NOx catalyst, if lean combustion operation of the internal combustion engine is carried out over a long period of time, the NOx absorptance of an occlusion reduction type NOx catalyst is saturated, and it will be emitted into atmospheric air, without removing the nitrogen oxides (NOx) under exhaust air according to an occlusion reduction type NOx catalyst.
[0006] Therefore, before the NOx absorptance of an occlusion reduction type NOx catalyst is saturated, it is necessary to make the nitrogen oxides (NOx) absorbed by the occlusion reduction type NOx catalyst emit and return by performing the so-called rich spike control to which the air-fuel ratio of the exhaust air which flows into this occlusion reduction type NOx catalyst is reduced, when applying an occlusion reduction type NOx catalyst to a lean combustion type internal combustion engine.
[0007] The approach of adding a reducing-agent slack fuel as the concrete approach of rich spike control during the exhaust air which flows the upstream from an occlusion reduction type NOx catalyst can be illustrated.
[0008] In addition, when adding a reducing agent during upstream exhaust air from an occlusion reduction type NOx catalyst, it is also important to control the addition of a reducing agent to accuracy according to the nitrogen oxides (NOx) absorbed by the occlusion reduction type NOx catalyst.
[0009] When the addition of a reducing agent is superfluously made [many] to the nitrogen oxides (NOx) with which this is absorbed by the occlusion reduction type NOx catalyst, an excessive reducing agent will be emitted into atmospheric air. It is because it will be emitted into atmospheric air, without saturating the NOx absorptance of an occlusion reduction type NOx catalyst, and purifying the nitrogen oxides (NOx) under exhaust air when the additions of a reducing agent run short to the nitrogen oxides (NOx) absorbed by the occlusion reduction type NOx catalyst.
[0010] By the former, an internal combustion engine's exhaust emission control device which was indicated by the patent No. 2845056 official report is proposed to such a problem. An internal combustion engine's exhaust emission control device indicated by this official report The amount of the reducing agent which is needed in order to return the nitrogen oxides (NOx) absorbed by the amount of the reducing agent which reacts with the oxygen under exhaust air and is consumed in an occlusion reduction type NOx catalyst, and the occlusion reduction type NOx catalyst is taken into consideration. By determining the addition of a reducing agent, it is going to control aggravation of the exhaust air emission according the overage and short supply of a reducing agent to prevention, with bleedoff into the atmospheric air of a reducing agent or nitrogen oxides (NOx).
[0011] Moreover, the method of using the exhaust-gas-recirculation (EGR:Exhaust Gas Recirculation) equipment to which the recirculation of a part of exhaust air which flows an internal combustion engine's flueway is carried out to this internal combustion engine's inhalation-of-air path as an approach of reducing the amount of the nitrogen oxides (NOx) discharged by the internal combustion engine is proposed.
[0012] EGR equipment reduces the amount of the nitrogen oxides (NOx) which the rate of combustion and combustion

temperature of gaseous mixture in an internal combustion engine's combustion chamber are reduced, with are generated at the time of combustion using the incombustibility which inert gas components, such as a steam (H2O) contained during exhaust air, a carbon monoxide (CO), and a carbon dioxide (CO2), have, and endoergic nature.

[0013] In addition, equipments of various configurations, such as the equipment which consists of EGR valves which adjust the flow rate of the exhaust air (EGR gas) which flows the inside of the EGR path which opens an internal combustion engine's flueway and inhalation-of-air path for free passage, and an EGR path as EGR equipment which was described above, and equipment which are constituted by preparing the EGR cooler for cooling EGR gas in addition to an EGR path and an EGR valve in the middle of an EGR path, are proposed.

[0014]

[Problem(s) to be Solved by the Invention] By the way, with the EGR equipment of the diesel power plant which performs rich spike control which was indicated by the official report mentioned above, when a NOx reduction catalyst is in a non-active state, SOF (Solible Organic Function) components contained in EGR gas, such as soot and unburnt hydrocarbon (HC), will flow into an EGR cooler, without being consumed by the NOx reduction catalyst. When such an event is repeated, there is a possibility that a SOF component may deposit on an EGR cooler and the blinding of an EGR cooler may occur.

[0015] Furthermore, with the EGR equipment of the above mentioned diesel power plant, since it does not have a means to detect the blinding of an EGR cooler or an EGR path, there is a case where it becomes difficult to carry out the recirculation of the EGR gas of the amount of requests to an inhalation-of-air path when the blinding of an EGR cooler or an EGR path occurs actually, consequently it becomes impossible to fully reduce the yield of the nitrogen oxides (NOx) in an internal combustion engine.

[0016] This invention is made in view of various problems which were described above, and aims at contributing to aggravation prevention of an internal combustion engine's exhaust air emission.

[0017]

[Means for Solving the Problem] The following means were used for this invention in order to solve the above-mentioned technical problem.

[0018] Namely, the exhaust emission control device of the internal combustion engine concerning this invention In the exhaust emission control device of the internal combustion engine possessing the EGR equipment which carries out the recirculation of a part of exhaust air to an internal combustion engine's inhalation-of-air system, and the EGR cooler which makes the EGR gas which recycles said EGR equipment cool An operational status detection means to detect said internal combustion engine's operational status, and an EGR gas thermometry means to measure the temperature of the EGR gas which recycles said EGR equipment, An EGR cooler cooling effectiveness presumption means to presume the cooling effectiveness of said EGR cooler based on the temperature of the EGR gas measured by the operational status detected by said operational status detection means, and said EGR gas thermometry means, An amount decision means of fuel main injection to determine the amount of the fuel which contains in a parameter the amount of the air inhaled by said internal combustion engine, and the amount of EGR gas, and is supplied to an internal combustion engine, An inhalation new-air-volume amendment means to amend the amount of the new mind inhaled by the changing internal combustion engine based on the EGR cooler cooling effectiveness presumed by said EGR cooler cooling effectiveness presumption means with said EGR cooler cooling effectiveness, An amount amendment means of EGR gas to amend the amount of the EGR gas inhaled by the changing internal combustion engine based on the EGR cooler cooling effectiveness presumed by said EGR cooler cooling effectiveness presumption means with said EGR cooler cooling effectiveness was provided.

[0019] Said EGR cooler cooling effectiveness presumption means can compute EGR cooling effectiveness based on a correlation with the EGR gas temperature after passing the cooling effectiveness of an EGR cooler and the EGR cooler which were called for beforehand.

[0020] Thus, in an internal combustion engine's constituted exhaust emission control device, a part of exhaust air discharged by the internal combustion engine is recycled in an inhalation-of-air system, and a recirculating gas (EGR gas) is inhaled with new mind in a combustion chamber. EGR gas serves not to burn oneself and to reduce combustion temperature, with the yield of nitrogen oxides (NOx) is controlled.

[0021] An EGR cooler performs heat exchange between EGR gas and a refrigerant, and cools EGR gas. While it will be lost that the ambient temperature of this combustion chamber rises unnecessarily when EGR gas is supplied to a combustion chamber since the volume of EGR gas is reduced if EGR gas is cooled, the amount of the new mind supplied to a combustion chamber does not decrease unnecessarily.

[0022] However, when plugging occurs in an EGR cooler, as compared with the case where plugging has not occurred, the heat exchange effectiveness in an EGR cooler falls.

[0023] On the other hand, the temperature of EGR gas after passing the EGR cooler of the typical condition (for example, new article condition) in predetermined operational status turns into fixed temperature according to the operational status.

[0024] Then, if the temperature of EGR gas before passing the temperature and the EGR cooler of EGR gas after passing the EGR cooler in the typical condition of being under a certain service condition is beforehand searched for in the experiment, the relation between EGR gas temperature and the effectiveness of an EGR cooler can be drawn.

[0025] An EGR cooler cooling effectiveness presumption means can presume the effectiveness of an EGR cooler using this relation by making temperature of exhaust air after EGR cooler passage into a parameter.

[0026] Said inhalation new-air-volume amendment means and said amount amendment means of EGR gas can illustrate an inhalation-of-air throttle valve and an EGR control valve, and its control unit, can change the rate of valve opening based on the cooling effectiveness of an EGR cooler, and can amend the new air volume and the amount of EGR gas which are inhaled in an internal combustion engine's combustion chamber.

[0027] As the above-mentioned EGR cooler, the cooler of the air cooling which performs heat exchange between atmospheric air and EGR gas, and the cooler of the water cooling type which performs heat exchange between predetermined cooling water and EGR gas can be illustrated. The cooling water for internal combustion engines is sufficient as predetermined cooling water, and it may be cooling water of the dedication for cooling only EGR gas.
[0028]
[Embodiment of the Invention] Hereafter, the concrete embodiment of the exhaust emission control device of the internal combustion engine concerning this invention is explained based on a drawing. Here, the case where the exhaust emission control device concerning this invention is applied to the Diesel engine for car actuation is mentioned as an example, and is explained.
[0029] Drawing 1 is drawing showing the outline configuration of the internal combustion engine which applies the exhaust emission control device concerning this invention, and its pumping system.
[0030] The internal combustion engine 1 which shows drawing 1 is 4 stroke Diesel engine of a water cooling type which has four cylinders 2.
[0031] The internal combustion engine 1 equips the combustion chamber of each cylinder 2 with the fuel injection valve 3 which injects a direct fuel. Each fuel injection valve 3 is connected with the accumulator (common rail) 4 which accumulates a fuel to place constant pressure. Common-rail-pressure sensor 4a which outputs the electrical signal corresponding to the pressure of the fuel in this common rail 4 is attached in this common rail 4.
[0032] Said common rail 4 is open for free passage with the fuel pump 6 through a fuel feeding pipe 5. This fuel pump 6 is a pump which operates considering the running torque of an internal combustion engine's 1 output shaft (crankshaft) as a driving source, and the pump pulley 6 attached in the input shaft of this fuel pump 6 is connected through crank-pulley 1a and the belt 7 which were attached in an internal combustion engine's 1 output shaft (crankshaft).
[0033] Thus, in the constituted fuel-injection system, if the running torque of a crankshaft is transmitted to the input shaft of a fuel pump 6, a fuel pump 6 will carry out the regurgitation of the fuel by the pressure according to the running torque transmitted to the input shaft of this fuel pump 6 from the crankshaft.
[0034] The fuel breathed out from said fuel pump 6 is supplied to a common rail 4 through a fuel feeding pipe 5, and pressure accumulation is carried out to place constant pressure with a common rail 4, and it is distributed to the fuel injection valve 3 of each cylinder 2. And if an actuation current is impressed to a fuel injection valve 3, a fuel injection valve 3 will open, consequently a fuel will be injected into a cylinder 2 from a fuel injection valve 3.
[0035] Next, the inhalation-of-air branch pipe 8 is connected to the internal combustion engine 1, and each branch pipe of the inhalation-of-air branch pipe 8 is open for free passage through the combustion chamber of each cylinder 2, and the inlet port which is not illustrated.
[0036] Said inhalation-of-air branch pipe 8 is connected to an inlet pipe 9, and this inlet pipe 9 is connected to the air cleaner box 10. The air flow meter 11 which outputs the electrical signal corresponding to the mass of the inhalation of air which flows the inside of this inlet pipe 9 to the down-stream inlet pipe 9, and the intake-air-temperature sensor 12 which outputs the electrical signal corresponding to the temperature of the inhalation of air which flows the inside of this inlet pipe 9 are attached from said air cleaner box 10.
[0037] The inhalation-of-air throttle valve 13 which adjusts the flow rate of the inhalation of air which flows the inside of this inlet pipe 9 is formed in the part in which it is located in the style of [of the inhalation-of-air branch pipe 8 in said inlet pipe 9] right above. The actuator 14 for inhalation-of-air drawing which consists of stepper motors etc. and carries out closing motion actuation of this inhalation-of-air throttle valve 13 is attached in this inhalation-of-air throttle valve 13.
[0038] Compressor housing 15a of the centrifugal supercharger (turbocharger) 15 which operates considering the heat energy of exhaust air as a driving source is prepared in the inlet pipe 9 located between said air flow meters 11 and said inhalation-of-air throttle valves 13, and the intercooler 16 for cooling the inhalation of air which was compressed into the down-stream inlet pipe 9 within said compressor housing 15a, and became an elevated temperature from compressor housing 15a is formed in it.
[0039] Thus, by the constituted inhalation-of-air system, the inhalation of air which flowed into the air cleaner box 10 flows into compressor housing 15a through an inlet pipe 9, after dust, dust, etc. under inhalation of air are removed by the air cleaner which is not illustrated in this air cleaner box 10.
[0040] The inhalation of air which flowed into compressor housing 15a is compressed by the revolution of a compressor wheel by which the inner package was carried out to this compressor housing 15a. After being cooled by the intercooler 16, if needed, by the inhalation-of-air throttle valve 13, the inhalation of air which was compressed within said compressor housing 15a, and became an elevated temperature has a flow rate adjusted, and flows into the inhalation-of-air branch pipe 8. The inhalation of air which flowed into the inhalation-of-air branch pipe 8 is distributed to the combustion chamber of each cylinder 2 through each branch pipe, and burns considering the fuel injected from the fuel injection valve 3 of each cylinder 2 as an ignition source.
[0041] On the other hand, the exhaust air branch pipe 18 is connected to an internal combustion engine 1, and it is open for free passage with the combustion chamber of each cylinder 2 through the exhaust port which each branch pipe of the exhaust air branch pipe 18 does not illustrate.
[0042] Said exhaust air branch pipe 18 is connected with turbine housing 15b of said centrifugal supercharger 15. Said turbine housing 15b is connected with an exhaust pipe 19, and this exhaust pipe 19 is connected to the muffler which is not illustrated on a lower stream of a river.
[0043] In the middle of said exhaust pipe 19, the exhaust air clarification catalyst 20 for purifying the harmful gas component under exhaust air is arranged. The air-fuel ratio sensor 23 which outputs the electrical signal corresponding to the air-fuel

ratio of the exhaust air which flows the inside of this exhaust pipe 19 to the down-stream exhaust pipe 19, and the exhaust-gas-temperature sensor 24 which outputs the electrical signal corresponding to the temperature of the exhaust air which flows the inside of this exhaust pipe 19 are attached from the exhaust air clarification catalyst 20.

[0044] The exhaust air throttle valve 21 which adjusts the flow rate of the exhaust air which flows the inside of this exhaust pipe 19 is formed in the down-stream exhaust pipe 19 from the above mentioned air-fuel ratio sensor 23 and the above mentioned exhaust-gas-temperature sensor 24. The actuator 22 for exhaust air drawing which consists of stepper motors etc. and carries out closing motion actuation of this exhaust air throttle valve 21 is attached in this exhaust air throttle valve 21.

[0045] Thus, by the constituted exhaust air system, the gaseous mixture (burned gas) which burned in each cylinder 2 of an internal combustion engine 1 is discharged through an exhaust port to the exhaust air branch pipe 18, and, subsequently flows into turbine housing 15b of a centrifugal supercharger 15 from the exhaust air branch pipe 18. The exhaust air which flowed into turbine housing 15b rotates the turbine wheel supported free [a revolution] in turbine housing 15b using the heat energy which this exhaust air has. The running torque of a turbine wheel is transmitted to the compressor wheel of compressor housing 15a mentioned above in that case.

[0046] The exhaust air discharged from said turbine housing 15b flows into the exhaust air clarification catalyst 20 through an exhaust pipe 19, and the harmful gas component under exhaust air is removed or purified. After the exhaust air removed or purified in the harmful gas component with the exhaust air clarification catalyst 20 has a flow rate adjusted by the exhaust air throttle valve 21 if needed, it is emitted into atmospheric air through a muffler.

[0047] Moreover, the exhaust air branch pipe 18 and the inhalation-of-air branch pipe 8 are opened for free passage through the exhaust-gas-recirculation path (EGR path) 25 which carries out the recirculation of a part of exhaust air which flows the inside of the exhaust air branch pipe 18 to the inhalation-of-air branch pipe 8. In the middle of this EGR path 25, it consists of solenoid valves etc. and the flow control valve (EGR valve) 26 which changes the flow rate of the exhaust air (EGR gas is called hereafter) which flows the inside of said EGR path 25 according to the magnitude of impression power is formed.

[0048] The EGR opening sensor 38 which outputs the electrical signal corresponding to the opening of this EGR valve 26 is attached in said EGR valve 26. The sensor of the photo interrupter method equipped with the potentiometer equipped with the metal contact which is interlocked with the switching action of the EGR valve 26, and slides on a resistor top as this EGR opening sensor 38, for example, and the slot disk which is interlocked with the switching action of the EGR valve 26, and rotates and the photo interrupter which consists of LED and the photo transistor which have been arranged so that it may counter through a slot disk etc. can be illustrated.

[0049] At said EGR path 25, EGR cooler 27 which cools the EGR gas which flows the inside of this EGR path 25 is formed in the upstream part from the EGR valve 26.

[0050] Thus, by the constituted exhaust-gas-recirculation device, if the EGR valve 26 is opened, the EGR path 25 will be in switch-on, a part of exhaust air which flows the inside of the exhaust air branch pipe 18 will flow into said EGR path 25, and it will be led to the inhalation-of-air branch pipe 8 through EGR cooler 27.

[0051] In that case, by EGR cooler 27, heat exchange will be performed between the EGR gas which flows the inside of the EGR path 25, and a predetermined refrigerant, and EGR gas will be cooled.

[0052] It is led to the combustion chamber of each cylinder 2, the EGR gas which flowed back from the exhaust air branch pipe 18 to the inhalation-of-air branch pipe 8 through the EGR path 25 being mixed with new mind of having flowed from the upstream of the inhalation-of-air branch pipe 8, and burns considering the fuel injected from a fuel injection valve 3 as an ignition source.

[0053] since the inert gas component which oneself does not burn and has endoergic nature like water (H2O) or a carbon dioxide (CO2) is contained in EGR gas here -- EGR gas -- gaseous mixture -- if contained in inside, the combustion temperature of gaseous mixture can lower, with the yield of nitrogen oxides (NOx) will be controlled.

[0054] Furthermore, while it is lost that the ambient temperature of this combustion chamber rises unnecessarily when EGR gas is supplied to a combustion chamber since the volume of EGR gas will be reduced while the temperature of EGR gas itself falls if EGR gas is cooled in EGR cooler 27, the amount (volume of new mind) of the new mind supplied to a combustion chamber does not decrease unnecessarily.

[0055] The exhaust air clarification catalyst 20 is a NOx catalyst which purifies the nitrogen oxides (NOx) under exhaust air under existence of a reducing agent. As such a NOx catalyst, although a selection reduction type NOx catalyst, an occlusion reduction type NOx catalyst, etc. can be illustrated, an occlusion reduction type NOx catalyst is mentioned as an example, and is explained here. Hereafter, the exhaust air clarification catalyst 20 shall be called the occlusion reduction type NOx catalyst 20.

[0056] The occlusion reduction type NOx catalyst 20 makes an alumina support. On the support Alkali metal, such as a potassium (K), sodium (Na), a lithium (Li), or caesium (Cs), At least one chosen from alkaline earths, such as barium (Ba) or calcium (calcium), and rare earth, such as a lanthanum (La) or an yttrium (Y), and noble metals, such as platinum (Pt), are supported, and it is constituted. In addition, the occlusion reduction type NOx catalyst which consists of gestalten of this operation by supporting barium (Ba) and platinum (Pt) on the support which consists of an alumina is mentioned as an example, and is explained.

[0057] Thus, the constituted occlusion reduction type NOx catalyst 20 absorbs the nitrogen oxides (NOx) under exhaust air, when the oxygen density of the exhaust air which flows into this occlusion reduction type NOx catalyst 20 is high.

[0058] On the other hand, the occlusion reduction type NOx catalyst 20 emits the nitrogen oxides (NOx) which were being absorbed, when the oxygen density of the exhaust air which flows into this occlusion reduction type NOx catalyst 20 falls. If reduction components, such as a hydrocarbon (HC) and a carbon monoxide (CO), exist during exhaust air in that case, the occlusion reduction type NOx catalyst 20 can make nitrogen (N2) return the nitrogen oxides (NOx) emitted from this

occlusion reduction type NOx catalyst 20.

[0059] In addition, although there is also a part which is not clarified about the NOx absorption/emission action of the occlusion reduction type NOx catalyst 20, it is thought that it is performed by the about following mechanisms.

[0060] First, in the occlusion reduction type NOx catalyst 20, if the air-fuel ratio of the exhaust air which flows into this occlusion reduction type NOx catalyst 20 turns into the Lean air-fuel ratio and the oxygen density under exhaust air increases, as shown in drawing 2 (A), the oxygen under exhaust air (O2) will adhere on the front face of platinum (Pt) in the form of O2- or O2-. The nitrogen monoxide under exhaust air (NO) reacts with O2- or O2- on the front face of platinum (Pt), and forms a nitrogen dioxide (NO2) (2 NO+O2 ->2NO2). A nitrogen dioxide (NO2) oxidizes further on the front face of platinum (Pt), and is absorbed by the occlusion reduction type NOx catalyst 20 in the form of nitrate ion (NO3-). In addition, it combines with the barium oxide (BaO) and the nitrate ion (NO3-) absorbed by the occlusion reduction type NOx catalyst 20 forms a barium nitrate (Ba2 (NO3)).

[0061] Thus, when the air-fuel ratio of the exhaust air which flows into the occlusion reduction type NOx catalyst 20 is the Lean air-fuel ratio, the nitrogen oxides (NOx) under exhaust air are absorbed by the occlusion reduction type NOx catalyst 20 as nitrate ion (NO3-).

[0062] The air-fuel ratio of inflow exhaust air is the Lean air-fuel ratio, and NOx absorption which was described above is continued unless the NOx absorptance of the occlusion reduction type NOx catalyst 20 is saturated. Therefore, when the air-fuel ratio of the exhaust air which flows into the occlusion reduction type NOx catalyst 20 is the Lean air-fuel ratio, unless the NOx absorptance of the occlusion reduction type NOx catalyst 20 is saturated, the nitrogen oxides (NOx) under exhaust air will be absorbed by the occlusion reduction type NOx catalyst 20, and nitrogen oxides (NOx) will be removed out of exhaust air.

[0063] On the other hand, with the occlusion reduction type NOx catalyst 20, if the oxygen density of the exhaust air which flows into this occlusion reduction type NOx catalyst 20 falls, in order that the amount of generation of a nitrogen dioxide (NO2) may decrease on the front face of platinum (Pt), the nitrate ion (NO3-) combined with the barium oxide (BaO) becomes reverse with a nitrogen dioxide (NO2) and a nitrogen monoxide (NO), and it secedes from the occlusion reduction type NOx catalyst 20.

[0064] If reduction components, such as a hydrocarbon (HC) and a carbon monoxide (CO), exist during exhaust air in that case, those reduction components will react selectively with the oxygen (O2- or O2-) on platinum (Pt), and will form active species. This active species makes nitrogen (N2) return the nitrogen dioxide (NO2) and nitrogen monoxide (NO) which were emitted from the occlusion reduction type NOx catalyst 20.

[0065] Therefore, while the air-fuel ratio of the exhaust air which flows into the occlusion reduction type NOx catalyst 20 turns into theoretical air fuel ratio or a rich air-fuel ratio and the oxygen density under exhaust air falls, when the concentration of a reducing agent increases, the nitrogen oxides (NOx) absorbed by the occlusion reduction type NOx catalyst 20 will be emitted and returned, with the NOx absorptance of the occlusion reduction type NOx catalyst 20 will be reproduced.

[0066] By the way, although the nitrogen oxides (NOx) contained during exhaust air will be absorbed by the occlusion reduction type NOx catalyst 20 since the air-fuel ratio of the exhaust air discharged by the internal combustion engine 1 serves as lean atmosphere and the oxygen density of exhaust air becomes high when lean combustion operation of the internal combustion engine 1 is carried out If lean combustion operation of an internal combustion engine 1 is continued for a long period of time, the NOx absorptance of the occlusion reduction type NOx catalyst 20 will be saturated, and it will be emitted into atmospheric air, without removing the nitrogen oxides (NOx) under exhaust air with the occlusion reduction type NOx catalyst 20.

[0067] Since the gaseous mixture of the Lean air-fuel ratio burns in most operating range and the air-fuel ratio of exhaust air turns into the Lean air-fuel ratio in most operating range according to it, the NOx absorptance of the occlusion reduction type NOx catalyst 20 tends [especially] to be saturated with a Diesel engine like an internal combustion engine 1.

[0068] Therefore, when lean combustion operation of the internal combustion engine 1 is carried out, it is necessary to raise the concentration of a reducing agent, while reducing the oxygen density under exhaust air which flows into the occlusion reduction type NOx catalyst 20 before the NOx absorptance of the occlusion reduction type NOx catalyst 20 is saturated, and to make the nitrogen oxides (NOx) absorbed by the occlusion reduction type NOx catalyst 20 emit and return.

[0069] On the other hand, by having the reducing-agent feeder style which adds a reducing-agent slack fuel (gas oil) during the exhaust air which flows an upstream flueway, and adding a fuel into exhaust air from this reducing-agent feeder style from the occlusion reduction type NOx catalyst 20, the exhaust emission control device of the internal combustion engine concerning the gestalt of this operation raised the concentration of a reducing agent while reducing the oxygen density of the exhaust air which flows into the occlusion reduction type NOx catalyst 20.

[0070] The reducing-agent injection valve 28 which a reducing-agent feeder style opens when it is attached in an internal combustion engine's 1 cylinder head so that the nozzle hole may face in the exhaust air branch pipe 18 and the fuel more than a predetermined injection-valve opening pressure is impressed, as shown in drawing 1 , and injects a fuel, The reducing-agent supply way 29 which leads the fuel breathed out from the fuel pump 6 mentioned above to said reducing-agent injection valve 28, The flow control valve 30 which adjusts the flow rate of the fuel which is prepared in the middle of this reducing-agent supply way 29, and flows the inside of this reducing-agent supply path 29, The isolation valve 31 which is prepared in the upstream reducing-agent supply way 29, and intercepts the flow of the fuel in this reducing-agent supply way 29 from this flow control valve 30, It has the reducing-agent pressure sensor 32 which is attached in the upstream reducing-agent supply way 29 from said flow control valve 30, and outputs the electrical signal corresponding to the pressure in this reducing-agent supply way 29.

[0071] In addition, as for the reducing-agent injection valve 28, it is desirable that the nozzle hole of this reducing-agent injection valve 28 is attached in the cylinder head so that the set section of the exhaust air branch pipe 18 may be turned to at least from a connection with the EGR path 25 in the exhaust air branch pipe 18, while projecting in the exhaust port of the cylinder 2 nearest to [are a lower stream of a river and] the set section of four branch pipes in the exhaust air branch pipe 18.

[0072] This is for making it reach to turbine housing 15b of a centrifugal supercharger, without a reducing agent being overdue in the exhaust air branch pipe 18 while the reducing agent (fuel component of non-**) injected from the reducing-agent injection valve 28 flows into the EGR path 25, it becomes the cause of the blinding of an EGR cooler or it prevents that mix with inhalation of air and an air-fuel ratio becomes small.

[0073] In addition, although the reducing-agent injection valve 28 is attached in the exhaust port of the No. 1 (#1) cylinder 2 in the example shown in drawing 1 since the No. 1 (#1) cylinder 2 is in the set section of the exhaust air branch pipe 18, and the nearest location among four cylinders 2 of an internal combustion engine 1 When cylinders 2 other than No. 1 (#1) cylinder 2 are in the set section of the exhaust air branch pipe 18, and the nearest location, the reducing-agent injection valve 28 is attached in the exhaust port of the cylinder 2.

[0074] Moreover, said reducing-agent injection valve 28 approaches penetration or a water jacket, the water jacket which was formed in the cylinder head and which is not illustrated is attached, and you may make it cool the reducing-agent injection valve 28 using the cooling water which flows said water jacket.

[0075] At such reducing-agent feeder guard, valve opening of a flow control valve 30 impresses the high-pressure fuel breathed out from the fuel pump 6 through the reducing-agent supply way 29 to the reducing-agent injection valve 28. And if the pressure of the fuel impressed to the reducing-agent injection valve 28 reaches more than an injection-valve opening pressure, this reducing-agent injection valve 28 will open, and the fuel as a reducing agent will be injected into the exhaust air branch pipe 18.

[0076] the exhaust air with which the reducing agent injected into the exhaust air branch pipe 18 from the reducing-agent injection valve 28 has flowed from the upstream of the exhaust air branch pipe 18 -- ** -- it both flows into turbine housing 15b. It is agitated by the revolution of a turbine wheel, homogeneity is mixed, and the exhaust air and the reducing agent which flowed in turbine housing 15b form exhaust air of a rich air-fuel ratio.

[0077] Thus, exhaust air of the formed rich air-fuel ratio flows into the occlusion reduction type NOx catalyst 20 through an exhaust pipe 19 from turbine housing 15b, and it will be returned to nitrogen (N2), making the nitrogen oxides (NOx) absorbed by the occlusion reduction type NOx catalyst 20 emit.

[0078] Then, when clausilium of the flow control valve 30 is carried out and supply of the reducing agent from the fuel pump 6 to the reducing-agent injection valve 28 is intercepted, the pressure of the fuel impressed to the reducing-agent injection valve 28 becomes said under injection-valve opening pressure, consequently the reducing-agent injection valve 28 will close the valve, and addition of the reducing agent into the exhaust air branch pipe 18 will be stopped.

[0079] The electronic control unit (ECU:Electronic Control Unit) 35 for controlling this internal combustion engine 1 is put side by side in the internal combustion engine 1 constituted as stated above. This ECU35 is a unit which controls an internal combustion engine's 1 operational status according to an internal combustion engine's 1 service condition, or a demand of an operator.

[0080] Common-rail-pressure sensor 4a, an air flow meter 11, the intake-air-temperature sensor 12, the pressure-of-induction-pipe force sensor 17, the air-fuel ratio sensor 23, the exhaust-gas-temperature sensor 24, the reducing-agent pressure sensor 32, the crank position sensor 33, a coolant temperature sensor 34, the accelerator opening sensor 36, the EGR opening sensor 38, and the various sensors of EGR gas temperature sensor 37 grade are connected to ECU35 through electric wiring, and the output signal of the various above-mentioned sensors is inputted into ECU35.

[0081] On the other hand, it enables ECU35 to control each part which connected through electric wiring and a fuel injection valve 3, the actuator 14 for inhalation-of-air drawing, the actuator 22 for exhaust air drawing, the EGR valve 26, the flow control valve 30, and the isolation valve 31 grade described above at ECU35.

[0082] Here, ECU35 is equipped with A/D converter (A/D) 355 connected to said input port 356 while it is equipped with CPU351, ROM352 and RAM353, the backup RAM 354 and input port 356 that were mutually connected by the bidirectional bus 350, and an output port 357, as shown in drawing 3 .

[0083] Said input port 356 inputs the output signal of the sensor which outputs the signal of a digital signal format like the crank position sensor 33, and transmits those output signals to CPU351 or RAM353.

[0084] Said input port 356 is inputted through A/D355 of the sensor which outputs the signal of an analog signal format like common-rail-pressure sensor 4a, an air flow meter 11, the intake-air-temperature sensor 12, the pressure-of-induction-pipe force sensor 17, the air-fuel ratio sensor 23, the exhaust-gas-temperature sensor 24, the reducing-agent pressure sensor 32, a coolant temperature sensor 34, the accelerator opening sensor 36, the EGR opening sensor 38, and EGR gas temperature sensor 37 grade, and transmits those output signals to CPU351 or RAM353.

[0085] It connects with a fuel injection valve 3, the actuator 14 for inhalation-of-air drawing, the actuator 22 for exhaust air drawing, the EGR valve 26, a flow control valve 30, and isolation valve 31 grade through electric wiring, and said output port 357 transmits the control signal outputted from CPU351 to the above mentioned fuel injection valve 3, the actuator 14 for inhalation-of-air drawing, the actuator 22 for exhaust air drawing, the EGR valve 26, a flow control valve 30, or an isolation valve 31.

[0086] A fuel-injection control routine for said ROM352 to control a fuel injection valve 3, The exhaust air throttling control routine for controlling the inhalation-of-air throttling control routine for controlling the inhalation-of-air throttle valve 13, and the exhaust air throttle valve 21, The NOx clarification control routine for purifying the nitrogen oxides (NOx) absorbed by

the EGR control routine for controlling the EGR valve 26, and the occlusion reduction type NOx catalyst 20, Application programs, such as a poisoning dissolution control routine for canceling poisoning by the oxide of the occlusion reduction type NOx catalyst 20, are memorized.

[0087] In addition to the above-mentioned application program, said ROM352 has memorized various kinds of control maps. Said control map For example, the fuel-oil-consumption control map in which the relation between an internal combustion engine's 1 operational status and basic fuel oil consumption (basic fuel injection duration) is shown, The fuel-injection-timing control map in which the relation between an internal combustion engine's 1 operational status and basic fuel injection timing is shown, The inhalation-of-air throttle valve opening control map in which the relation between an internal combustion engine's 1 operational status and the target opening of the inhalation-of-air throttle valve 13 is shown, The inhalation new-air-volume amendment map in which the relation between the cooling effectiveness of EGR cooler 27 and inhalation new air volume is shown, The exhaust air throttle valve opening control map in which the relation between an internal combustion engine's 1 operational status and the target opening of the exhaust air throttle valve 21 is shown, Whenever [EGR valve-opening / which shows the relation between an internal combustion engine's 1 operational status and the target opening of the EGR valve 26] A control map, The amount amendment map of EGR gas in which the relation between the cooling effectiveness of EGR cooler 27 and the amount of need EGR(s) is shown, The EGR cooler effectiveness presumption map, the target addition of an internal combustion engine's 1 operational status, and a reducing agent (or) which show the relation between EGR gas temperature and the cooling effectiveness of EGR cooler 27 They are the reducing-agent addition control map in which relation with the target air-fuel ratio of exhaust air is shown, the flow control valve control map in which the relation between the target addition of a reducing agent and the valve-opening time amount of a flow control valve 30 is shown.

[0088] Said RAM353 stores the output signal from each sensor, the result of an operation of CPU351, etc. Said result of an operation is an engine rotational frequency by which the crank position sensor 33 is computed based on time spacing which outputs a pulse signal. These data are rewritten by the newest data whenever the crank position sensor 33 outputs a pulse signal.

[0089] Said backup RAM 354 is the memory of the non-volatile after an internal combustion engine's 1 shutdown can remember data to be.

[0090] Said CPU351 operates according to the application program memorized by said ROM352, and performs fuel injection valve control, inhalation-of-air throttling control, exhaust air throttling control, EGR control, NOx clarification control, poisoning dissolution control, and EGR cooler cooling effectiveness presumption control.

[0091] For example, in fuel injection valve control, CPU351 determines first the fuel quantity injected from a fuel injection valve 3, and determines the stage to inject a fuel from a fuel injection valve 3 subsequently.

[0092] When determining fuel oil consumption, CPU351 reads the engine rotational frequency memorized by RAM353 and the output signal (accelerator opening) of the accelerator opening sensor 36. CPU351 is accessed to a fuel-oil-consumption control map, and computes said engine rotational frequency and the basic fuel fuel oil consumption (basic fuel injection duration) corresponding to said accelerator opening. CPU351 amends said basic fuel injection duration based on the output signal value of an air flow meter 11, the intake-air-temperature sensor 12, and coolant temperature sensor 34 grade etc., and determines final fuel injection duration.

[0093] When determining fuel injection timing, CPU351 is accessed to a fuel-injection initiation stage control map, and computes the basic fuel injection timing corresponding to said engine rotational frequency and said accelerator opening. CPU351 amends said basic fuel injection timing by making the output signal value of an air flow meter 11, the intake-air-temperature sensor 12, and coolant temperature sensor 34 grade into a parameter, and determines final fuel injection timing.

[0094] If fuel injection duration and fuel injection timing are determined, CPU351 compares said fuel injection timing and output signal of the crank position sensor 33, and when the output signal of said crank position sensor 33 is in agreement with said fuel-injection initiation stage, it will start the impression of actuation power to a fuel injection valve 3. CPU351 stops the impression of actuation power to a fuel injection valve 3, when the elapsed time from the event of starting the impression of actuation power to a fuel injection valve 3 reaches said fuel injection duration.

[0095] In addition, when an internal combustion engine's 1 operational status is in idle operational status in fuel-injection control, CPU351 computes an internal combustion engine's 1 target idle rpm by making into a parameter the output signal value of a coolant temperature sensor 34, the operating state of the auxiliary machinery which operate like the compressor of the air conditioner for the vehicle interior of a room using the turning effort of a crankshaft, etc. And CPU351 carries out feedback control of the fuel oil consumption so that actual idle rpm may be in agreement with target idle rpm.

[0096] Moreover, in inhalation-of-air throttling control, CPU351 reads the engine rotational frequency and accelerator opening which are memorized by RAM353. CPU351 is accessed to an inhalation-of-air throttle valve opening control map, and computes the target inhalation-of-air throttle valve opening corresponding to an engine rotational frequency and an accelerator opening. CPU351 impresses the actuation power corresponding to said target inhalation-of-air throttle valve opening to the actuator 14 for inhalation-of-air drawing. In that case, CPU351 detects the actual opening of the inhalation-of-air throttle valve 13, and may be made to carry out feedback control of said actuator 14 for inhalation-of-air drawing based on the difference of the opening of the actual inhalation-of-air throttle valve 13, and a target inhalation-of-air throttle valve opening.

[0097] Moreover, CPU351 controls the actuator 22 for exhaust air drawing by exhaust air throttling control that the exhaust air throttle valve 21 should be driven in the direction of clausilium, when an internal combustion engine 1 is in the warm-up condition after start up between the colds, or when the heater for the vehicle interior of a room is in an operating state.

[0098] in this case, an internal combustion engine's 1 load increases and the quantity of fuel oil consumption is increased corresponding to it -- things -- ** Consequently, while an internal combustion engine's 1 calorific value increases and an internal combustion engine's 1 warming up is promoted, the heat source of the heater for the vehicle interior of a room is secured.

[0099] Moreover, in EGR control, CPU351 reads the engine rotational frequency memorized by RAM353, the output signal (circulating water temperature) of a coolant temperature sensor 34, the output signal (accelerator opening) of the accelerator opening sensor 36, etc., and distinguishes whether the execution condition of EGR control is satisfied.

[0100] as the above-mentioned EGR control execution condition, the variation of the accelerator opening by which the internal combustion engine 1 is continuously operated beyond predetermined time from the time of start up which has a circulating water temperature beyond predetermined temperature is a positive value -- etc. -- conditions can be illustrated.

[0101] When it judges with an EGR control execution condition which was described above being satisfied, CPU351 is accessed to a control map whenever [EGR valve-opening] by making an engine rotational frequency and an accelerator opening into a parameter, and computes whenever [corresponding to said engine rotational frequency and said accelerator opening / target EGR valve-opening]. CPU351 impresses the actuation power corresponding to whenever [said target EGR valve-opening] to the EGR valve 26. When it judges with on the other hand an EGR control execution condition which was described above not being satisfied, CPU351 is controlled that the EGR valve 26 should be held in the close-by-pass-bulb-completely condition.

[0102] Next, the EGR control concerning the gestalt of this operation is explained.

[0103] In the EGR control concerning the gestalt of this operation, CPU351 performs the so-called EGR valve feedback control which carries out feedback control of the opening of the EGR valve 26 by making an internal combustion engine's 1 inhalation new air volume into a parameter.

[0104] In EGR valve feedback control, CPU351 determines an internal combustion engine's 1 target inhalation new air volume by making an accelerator opening, an engine rotational frequency, etc. into a parameter, for example. In that case, relation between an accelerator opening, an engine rotational frequency, and target inhalation new air volume is map-ized beforehand, and target inhalation new air volume is computed from the map, accelerator opening, and engine rotational frequency.

[0105] Here, since the heat exchange effectiveness in an EGR cooler falls as compared with the case where plugging has not occurred and EGR gas temperature rises when plugging occurs in an EGR cooler, according to the cooling effectiveness of an EGR cooler, the amount of EGR gas and inhalation new air volume must be changed from the demand of emission.

[0106] That is, if the cooling effectiveness of an EGR cooler is falling, since cooling of the EGR gas inhaled by the cylinder 2 will become imperfection and the ambient temperature of a cylinder 2 will become high, the consistency of EGR gas becomes small. In order to fill the demand of emission, it must stop thereby, having to supply more EGR gas to a cylinder 2. Such relation can be shown as a correlation of EGR cooler effectiveness and the amount of need EGR gas for every engine load, as shown in drawing 5 .

[0107] On the other hand, since the temperature of the new mind inhaled by the cylinder 2 rises and a charging efficiency falls so that the cooling effectiveness of an EGR cooler is low, the amount of the new mind inhaled to a cylinder 2 is made to increase. Such relation can be shown as a correlation of EGR cooler effectiveness and inhalation new air volume for every engine load, as shown in drawing 6 .

[0108] In order to prevent aggravation of emission, it is necessary to make a cylinder 2 inhale the proper amount of EGR gas and inhalation new air volume which amended the amount of EGR gas, and inhalation new air volume, and balanced the operational status at that time. This amendment approach is shown below.

[0109] In predetermined operational status, since the temperature of EGR gas after passing the temperature of exhaust air and EGR cooler 27 of a new article condition turns into fixed temperature according to the operational status, if the temperature of EGR gas before passing the temperature and EGR cooler 27 of EGR gas after passing EGR cooler 27 of a new article condition is beforehand searched for in the experiment, the relation of EGR gas temperature and the cooling effectiveness of EGR cooler 27 as shown in drawing 4 can be drawn.

[0110] If ROM352 is made to memorize beforehand by using this relation as an EGR cooler effectiveness presumption map, the effectiveness of EGR cooler 27 will be presumed by making into a parameter temperature of the EGR gas after the EGR cooler 27 passage obtained from the output signal of the EGR gas temperature sensor 37.

[0111] Moreover, the required amount of EGR gas is computable from the EGR cooler cooling effectiveness in this time with drawing 5 . This computed required amount of EGR gas is memorized by RAM353. If it map-izes beforehand in quest of the valve-opening variation of the EGR valve 26 from which this required amount of EGR gas is obtained, and the inhalation-of-air throttle valve 13 by experiment and ROM352 is made to memorize, based on the required amount of EGR gas, the amount of valve-opening amendments of the EGR valve 26 and the inhalation-of-air throttle valve 13 is computable.

[0112] CPU351 can change the amount of valve opening of the EGR valve 26 and the inhalation-of-air throttle valve 13 based on said computed amount of valve-opening amendments, and can amend the amount of EGR gas, and inhalation new air volume.

[0113] On the other hand, inhalation new air volume is computable from the EGR cooler cooling effectiveness in this time with drawing 6 . This computed inhalation new air volume is memorized by RAM353. The inhalation new air volume computed simultaneously is memorized by RAM353 as amendment target inhalation new air volume.

[0114] If amendment target inhalation new air volume is determined by the above-mentioned procedure, CPU351 reads the output signal value (actual inhalation new air volume) of the air flow meter 11 memorized by RAM353, and measures actual inhalation new air volume and amendment target inhalation new air volume.

[0115] When there is less above mentioned actual inhalation new air volume than amendment target inhalation new air volume, CPU351 carries out specified quantity clausilium of the EGR valve 26, and carries out specified quantity valve opening of the inhalation-of-air throttle valve 13. In this case, the amount of EGR gas which flows into the inhalation-of-air branch pipe 8 from the EGR path 25 will decrease, and the amount of EGR gas inhaled in an internal combustion engine's 1 cylinder 2 according to it will decrease. Consequently, only the part to which EGR gas decreased increases the amount of the new mind inhaled in an internal combustion engine's 1 cylinder 2.

[0116] On the other hand, when there is more actual inhalation new air volume than amendment target inhalation new air volume, CPU351 carries out specified quantity valve opening of the EGR valve 26, and carries out specified quantity clausilium of the inhalation-of-air throttle valve 13. In this case, the amount of EGR gas which flows into the inhalation-of-air branch pipe 8 increases from the EGR path 25, and the amount of EGR gas inhaled in an internal combustion engine's 1 cylinder 2 according to it increases. Consequently, only the part from which EGR gas increased the amount of the new mind inhaled in an internal combustion engine's 1 cylinder 2 will decrease.

[0117] Based on EGR cooler effectiveness, amendment of inhalation new air volume and amendment of the amount of EGR gas are attained as mentioned above.

[0118] Thus, Air Fuel Ratio Control corresponding to cooling effectiveness change of an EGR cooler can be performed, and aggravation of exhaust air emission can be prevented.

[0119]

[Effect of the Invention] The exhaust emission control device of the internal combustion engine concerning this invention can presume EGR cooler effectiveness from EGR gas temperature, and can amend the amount of EGR gas, and inhalation new air volume from this presumed EGR cooler effectiveness.

[0120] Consequently, the amount of EGR gas and inhalation new air volume can be rationalized, and aggravation of exhaust air emission can be controlled.

[Translation done.]

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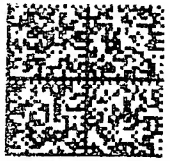

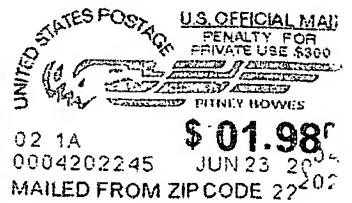

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